New Scientist

WEEKLY 1 February 2025

WHAT TRUMP'S RETURN MEANS FOR THE CLIMATE, PANDEMICS AND MORE

DID DINOSAURS FIRST EVOLVE IN THE AMAZON?

STRANGE ICY BALLS MAY BE A NEW KIND OF STAR

QUANTUM BLACK HOLES

They could appear out of nowhere and solve the biggest mystery in physics

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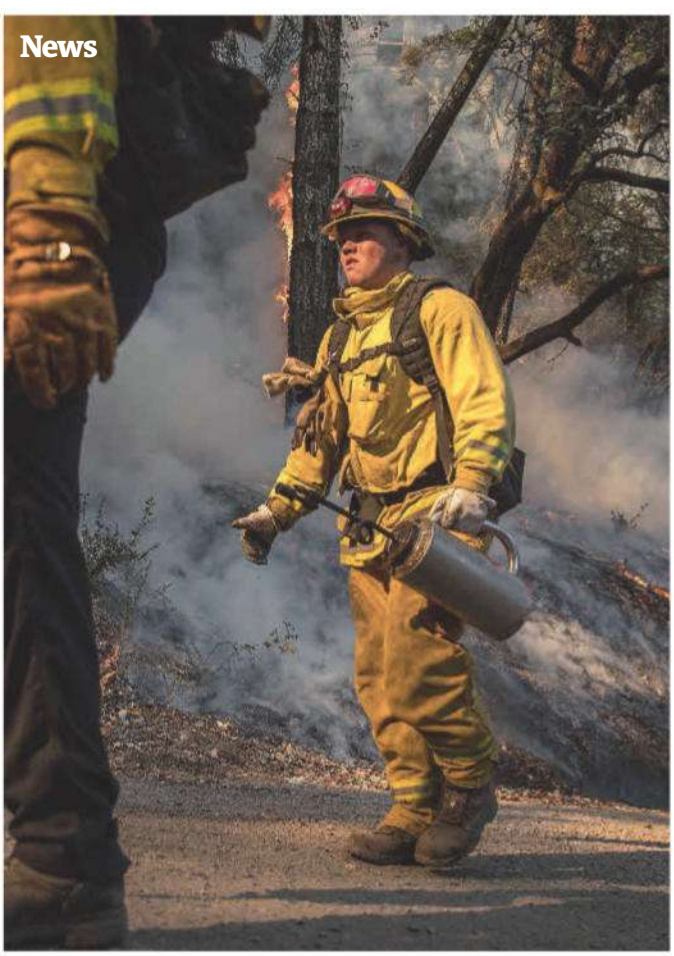

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Instant Expert

Live long and prosper

Research into longevity and human well-being has exploded in recent years. But are longevity advocates selling snake oil or are there genuine interventions that will let us live longer? And can science really help you become more fulfilled? Join six experts on 8 February at London's Congress Centre to discover if science has the answers to a longer, healthier life.

newscientist.com/events

Tour

Fossil hunting in the Gobi desert: Mongolia

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Podcast

Weekly

The team examine the nocebo effect, also known as the evil twin of the placebo effect. They discuss what Donald Trump pulling the US out of the Paris climate agreement and the World Health Organization means for the US and the rest of us. Plus, there is an update on the mysterious source of oxygen recently found in the deep sea.

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Flaming Cliffs Visit iconic dinosaur fossil sites in Mongolia

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As old as you feel Can science offer a route to a longer life?

Video

Free like a mushroom

The mushroom coral *Cycloseris cyclolites* is free-living, meaning it doesn't attach to a base substrate and migrates to different reef habitats in search of the right lighting conditions for survival and reproduction. Researchers at the Queensland University of Technology, Australia, have used time-lapse imaging to reveal how it does this via "pulsed inflation".

youtube.com/newscientist

Newsletter

The Earth Edition

In January, Donald Trump was inaugurated as the new US president and promptly signed a range of executive orders to halt climate action and slow the clean energy transition. Environment reporter Madeleine Cuff asks: how much impact will these measures have on the global drive to cut emissions?

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Podcast

"If people think they are getting an inferior medicine, they report more ill effects"

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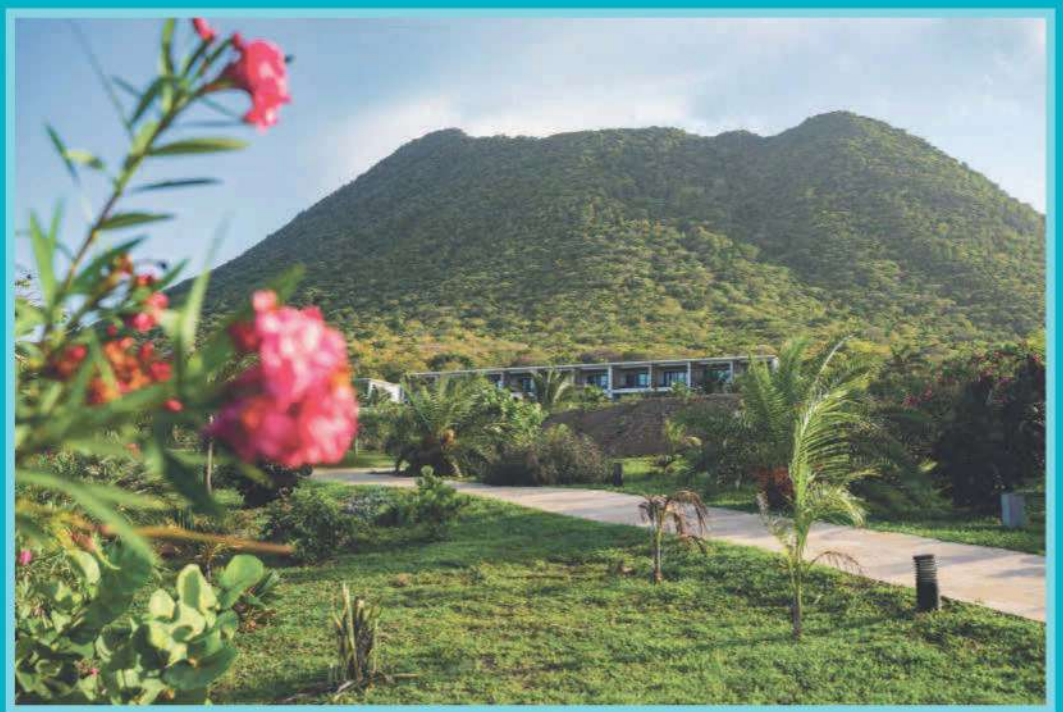

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What's in a name?

Psychology research can help guide leaders towards a true meritocracy

IN THE late 18th century, mathematician and physicist Joseph-Louis Lagrange made a shocking discovery: his star student, a Monsieur Le Blanc, was actually a woman.

Lagrange taught at France's École Polytechnique, which allowed students to study remotely. This was particularly beneficial to Sophie Germain, who longed to study mathematics despite objections from her parents. She took up the identity of a lapsed student, but Lagrange noticed the sudden improvement in Le Blanc's work and demanded to meet in person.

Germain isn't the only person to note how the name we use changes the way we are perceived. As psychologist Keon West explains on page 38, experiments using identical job applications show that those with names assumed to belong to a Black person are less successful than those with names thought to belong to a white person.

In recent years, many organisations have adopted measures to combat the biases that lead to these outcomes, such as removing names from job applications. These measures fall under the umbrella of diversity, equity and inclusion (DEI). Now, however, US President Donald Trump has ordered government agencies to dismantle DEI programmes, promising that society would be "merit-based".

"Trump's approach to diversity, equity and inclusion is unlikely to produce a meritocracy"

As the résumé test demonstrates, merit alone isn't enough to overcome people's biases, and a number of studies have shown that anonymising applications does tend to improve outcomes for disadvantaged groups.

Trump's heavy-handed approach to DEI is unlikely to produce his desired outcome of a meritocracy. Instead, the current efforts seem to be fostering a culture of fear, with government workers being warned of "adverse consequences" for failing to identify and end DEI work.

Thankfully for Germain, there were no such consequences. Lagrange accepted her for who she was and championed her mathematical development. If we want more Germains to flourish, we must acknowledge and address the barriers they face, not pretend that they don't exist. ▮

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Rush of water into the Mediterranean Sea shaped Sicily p17

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Environment

Giant berg heads for South Georgia

THE world's largest iceberg, pictured above, is heading towards the wildlife haven of South Georgia. If it runs aground here, it could make feeding hard for the penguins living on the island, including gentoos (left). Known as A23a, the iceberg is around 3500 square kilometres in size. It calved from Antarctica's Filchner-Ronne ice shelf in 1986 before lodging on the seafloor, breaking free again in 2020.

Analysis US politics

Trump's first week

With a blitz of executive orders, the new US president set the country on a path to derail climate goals, biomedical research and pandemic readiness, reports Chelsea Whyte

IN THE first week of his second term, US President Donald Trump has thrown the country's scientific apparatus into chaos. In some cases, the impacts may be felt for decades to come.

On 20 January, the first day of his presidency, Trump declared a "national energy emergency" and proposed expanding fossil fuel production on federal land, including a controversial move to open Alaska's Arctic National Wildlife Refuge for drilling and mining. He also enacted a temporary ban on federal permits for wind energy projects.

The biggest blow to climate action was the US's withdrawal from the Paris Agreement. This was Trump's second withdrawal attempt – the first, which came into effect in 2019, was later reversed by then-President Joe Biden. This time, the US will be out for at least the majority of Trump's presidency, a move that could lead to lowered climate commitments from major domestic industries. While the clean energy transition is likely to continue around the world, Trump has effectively sidelined the US.

"The world has just endured yet another hottest year on record, with countless communities reeling from a spate of deadly and costly climate-driven disasters," said Rachel Cleetus at the Union of Concerned Scientists in a statement. "The Trump administration seems hell-bent on worsening the toll by greatly expanding fossil fuels while stymying progress on clean energy and climate resilience."

The impact of these policies may be exacerbated by Trump's desire to speed up the rollout of energy-intensive artificial intelligence development, which threatens to strain the US electrical grid and potentially increase greenhouse gas emissions. With tech billionaires, including Jeff Bezos, Mark Zuckerberg and Elon Musk, front and centre at Trump's inauguration, it is clear the new president wants a rapid acceleration of AI. He rescinded a Biden order requiring AI developers to share safety information with the government, while also announcing a $500 billion plan to build massive data centres to support more AI development.

While Trump aims to make the US a global leader in AI, he is retreating from its existing leadership on health. One of his first moves was to withdraw from the World Health Organization (WHO). With the US fighting to hold back an outbreak of H5N1 bird flu in people, it is a dangerous time to walk away. The US contributes around 20 per cent of the WHO's total budget, so the loss will certainly hobble global vaccine programmes and surveillance for potential new pandemics. Global HIV and AIDS treatment programmes will take a hit as well, and could be further affected by another Trump order to pause foreign aid for 90 days .

The damage doesn't stop there: at the US National Institutes of Health (NIH), the largest public funder of biomedical research in the world, Trump abruptly cancelled the grant review process that helps fund research on everything from cancer to depression. NIH researchers have also reported that they can't purchase vital equipment to continue their current work. "We've never seen anything like this. This is like a meteor just crashed into all of our cancer centers and research areas," Victoria Seewaldt at City of Hope Comprehensive Cancer Center told *The Washington Post*.

> **"If his first week is anything to go by, Trump's presidency will be a dark age for science"**

In one of his most authoritarian moves, Trump enacted a gag order on major US health agencies, including the NIH, the Centers for Disease Control and Prevention (CDC) and the Food and Drug Administration, temporarily halting direct communications to the public. For the first time in more than 60 years , the CDC didn't release a key weekly report on deaths by disease and state. The same report in the 1980s led to the understanding that AIDS was an emerging epidemic.

Though some of these changes may be temporary, the limits on health agencies could have ramifications for months, while reversals in climate progress could reverberate for decades. Trump has promised that his presidency would bring about a "golden age" for the US – but if his first week is anything to go by, it will be a dark age for science. ▮

JIM WATSON/AFP/GETTY IMAGES

USFWS PHOTO/ALAMY

FABRICE COFFRINI/AFP VIA GETTY IMAGES

US President Donald Trump has signed an executive order to withdraw from the Paris Agreement (above), moved to open up Alaska's Arctic National Wildlife Refuge for further drilling (below) and withdrew from the World Health Organization (bottom)

Palaeontology

Dinosaurs may have first evolved in the Sahara and Amazon rainforest

Michael Marshall

DINOSAURS may have initially arisen close to the equator, not in the far south of the southern hemisphere as had been thought. A modelling study suggests they originated in a region that covers what is now the Amazon, Congo basin and Sahara desert.

"When you consider the gaps in the fossil record and the evolutionary tree of dinosaurs, it could very likely be a centre point for where dinosaurs originated," says Joel Heath at University College London.

Dinosaurs evolved during the Triassic Period, 252 to 201 million years ago, but Heath says there is "pretty huge" uncertainty about where and exactly when. The oldest known fossils are about 230 million years old, but they are distinct enough to suggest that dinosaurs had already existed for a few million years. "There must have been a lot going on in terms of dinosaur evolution, but we just don't have the fossils," he says.

At this time, Earth's continents were joined into a supercontinent called Pangaea, which was shaped like a C with its middle straddling the equator. South America and Africa were in the southern hemisphere segment. The earliest known dinosaurs are from far south in this area, in Argentina and Zimbabwe, and hence this was thought to be their point of origin.

To learn more, Heath and his colleagues built computer models to work backwards in time from the oldest known dinosaurs to the origin of the group. They created several dozen versions, to take into account uncertainties such as gaps in the fossil record, possible geographic barriers and ongoing doubts over how the earliest dinosaurs were related. Most of these simulations concluded that dinosaurs first appeared near the equator, with just a minority supporting the southerly origin (*Current Biology*, doi.org/n3zg).

Where dinosaurs originated has been heavily debated

MARK WITTON/NATURAL HISTORY MUSEUM, LONDON

Palaeontologists have tended to assume that dinosaurs couldn't have originated near the equator, says Heath, partly because there are no early dinosaur fossils from that region. What's more, it was a challenging place to live. "It was very, very dry and very hot," he says. "The dinosaurs were thought to have not been able to survive in those sorts of conditions."

Instead, the lack of early dinosaur fossils from near the equator may have a more prosaic explanation. Palaeontologists have tended to dig in North America and Europe, and more recently China. "There are lots of areas in the globe that are quite neglected," says Heath.

However, a piece of evidence in support of Heath's idea has emerged of late. On 8 January, researchers led by David Lovelace at the University of Wisconsin-Madison reported that they had found the oldest known dinosaur from the northern region of Pangaea. They found a new species of sauropodomorph in Wyoming, dated to 230 million years ago.

If dinosaurs were already in the north and south of Pangaea that long ago, the equatorial middle can't have been closed off to them, says Heath. "They have to have been crossing that region." ▮

Climate change

World is on track for up to 3.7°C of warming by 2100

CURRENT policies of governments around the world are likely to result in Earth warming by between 1.9 and 3.7°C by 2100, with potentially more to come in the 22nd century.

"Every year we keep emitting CO_2 after 2100 results in higher and higher global temperatures," says Zeke Hausfather, a climate scientist at Stripe, a California-based software company that invests in carbon-removal technology.

His conclusions are based on a review of more than a dozen studies published in the past five years looking at the implications of current policies. According to these studies, the world is most likely to warm by between 2.3 and 3°C by 2100 (*Dialogues on Climate Change*, doi.org/n3zd).

However, when uncertainties about future greenhouse gas emissions and how the climate system will respond to those emissions are included, it gives a broader range of 1.9 to 3.7°C .

These numbers reflect the most likely range of scenarios – the 5th to 95th percentiles – meaning there is a small chance of warming of as much as 4.4°C this century.

The good news is that the recent studies agree that very high emission scenarios are now unlikely. This is partly because the worst-case scenarios weren't that plausible, says Hausfather, but it also reflects progress in limiting emissions rises, with coal use now plateauing.

If climate policies are strengthened and technological advances exceed expectations, future emissions could be lower than envisaged – but this isn't guaranteed, and the rise of energy-hungry technologies like artificial intelligence could do the opposite.

"It's definitely possible to envision a world where AI rapidly accelerates and drives near-term emissions increases beyond what we think will happen today," says Hausfather, but he doesn't think AI-related emissions alone will make a huge difference in the long run. ▮

Michael Le Page

"It's possible to envision a world where AI rapidly accelerates and drives near-term emissions"

Physics

Crystal twist could boost electronics

Discovery could pave the way for coveted room-temperature superconductors

Alex Wilkins

A MYSTERIOUS form of superconductivity has been found in a twisted crystal, which could help us make super-efficient electronics.

Superconductivity is a rare property that lets some materials conduct electricity with no resistance. We only know of materials that are superconductors at low temperatures or extreme pressures, but a very high- or room-temperature superconductor could transform energy systems by allowing us to send limitless energy over vast distances.

In 2018, researchers unexpectedly found that when a sheet of graphene, an atom-thick layer of carbon, was stacked on top of another and rotated slightly, creating what is called a moiré pattern, it became a superconductor.

When they repeated this stacking and twisting with other materials, none showed superconductivity. It was unclear if the original superconductivity was just a quirk of graphene, or whether it might reveal more general principles for how to build a room-temperature superconductor.

Now, Cory Dean at Columbia University in New York and his colleagues have discovered superconductivity in a second atomically thin material, the metal tungsten diselenide. The property manifests when double-layered and twisted crystals of the substance are cooled to -272.724°C, around half a degree above absolute zero (*Nature*, doi.org/g82vs9).

> "There are hints that the superconductivity is a feature of the material's magnetic fields"

"Graphene isn't the only system that does this," says Dean. "That suggests that this could be a general property of moiré-patterned materials."

Dean and his team saw the first hints of superconductivity in tungsten diselenide soon after the graphene experiment. However, they couldn't properly measure the superconductivity because their electrical contacts stopped working as the temperatures were too low.

"We spent two years to three years trying to figure [it] out. How do we push that temperature window down and [have] our contacts survive?" says Dean. "Eventually we did that, and lo and behold, the superconductor re-emerged in our new sample."

Finding superconductivity in a material other than graphene suggests the existence of a new class of superconducting materials, says Joseph Betouras at Loughborough University, UK.

"Once you understand the details of these materials and what are the properties which lead to superconductivity, then you can start engineering materials with higher and higher temperatures, and eventually reach the goal [of room-temperature superconductivity]," he says.

It is still unclear exactly how tungsten diselenide is superconducting, says Dean, but there are hints that it is a feature of the material's magnetic fields that come from the interactions between the two twisted sheets. Dean and his team only detected the superconductivity next to regions where the magnetic fields are paired in opposite ways, such as a north and south pole lined up next to each other.

"That relationship between the onset of superconducting and the onset of magnetic ordering... gives us a good sense that this might be of a similar flavour to some of the unconventional superconductivity that is believed to exist in more conventional materials," says Dean. ▮

Health

Covid smell loss eased by injecting cells into the nose

PEOPLE who had lost their sense of smell after catching covid-19 partly regained it following the injection of blood cells called platelets into their noses, which could help to improve their quality of life.

A loss or change to your sense of smell or taste has been considered a common covid-19 symptom. "The SARS-CoV-2 virus enters cells in the nose, causing inflammation that can damage neurons, the cells that detect smells," says Zara Patel at Stanford University in California.

Most people regain their sense of smell within a few months, while others recover after receiving a therapy called smell training. This involves regularly sniffing different odours, such as coffee and lemons. "But that training doesn't work for a huge number of people," says Patel.

In search of another treatment, Patel and her colleagues turned to a therapy that seems to regenerate a range of tissues. It involves collecting a person's blood and filtering out plasma – a clear yellow liquid that contains platelets, blood cells that make regenerative proteins – before injecting this into the affected area.

To put it to the test, the team randomly assigned half of 32 people with covid-19-related smell loss to receive three platelet injections over six weeks, along with daily smell training.

TONY TALLEC/ALAMY

Loss of smell is a common symptom of a covid-19 infection

The remaining participants had the same treatment, except that they were injected with saline.

At the start of the study, the team found that the participants could identify around half of 40 odours, such as pineapple. One year later, the participants did the same test. Those who received the platelet injections could detect nine more odours than they could at the start, on average. The saline group identified an average of only one extra smell (*International Forum of Allergy & Rhinology*, doi.org/n3rt).

"Many patients returned to tell me of their joy in being able to smell special things – their favourite flower, the smell of fresh bread, being able to smell their new baby grandchild," says Patel. ▮

Carissa Wong

Technology

Holey battery may make wearables more breathable

Jeremy Hsu

A STRETCHY and flexible battery pouch filled with strategically placed holes is more breathable than cotton. That could make it an ideal power source for wearable fitness devices built into clothing.

"This is especially useful for athletes or individuals who wear electronics for extended periods – smart clothing for fitness tracking, medical monitoring devices and similar applications that demand both comfort and reliable performance," says Lin Xu at Yale University.

To design the new battery, Xu and his colleagues created a pattern of long, rectangular holes in a pouch cell battery – a type of lithium battery that resembles a flat bundle with a limited degree of bendability. Simulations showed how the array of rectangular holes enabled the battery to be stretched or folded 180 degrees without tearing, compared with alternative hole patterns involving squares or circles.

"One challenge was maintaining enough active material to keep the battery's energy density high – too many or too large holes would reduce the energy storage capacity," says Xu. "We had to balance mechanical stretchability with electrical performance."

When stretched by 10 per cent or folded up, the holey battery could resist physical stress and continue to power LED light bulbs – with the stretching and folding experiments each performed 100 times. Testing in a temperature and humidity chamber also showed that the battery was twice as breathable as cotton (*Matter*, doi.org/n3rw).

In a practical demonstration, the researchers wove the battery into a lab coat and tested its performance while the wearer exercised by running. They found its holes enabled the battery to quickly dissipate heat so it didn't feel painful or trap sweat on the wearer's skin.

Renewables

Use of wind and solar does expose nations to energy price spikes

Madeleine Cuff

PANORAMIC IMAGES/ALAMY

Wind makes up a lot of the power grid in some nations

NATIONS with large amounts of wind and solar in their power grids are particularly vulnerable to surging energy bills due to spikes in the price of gas. The relationship between decarbonisation and price volatility has been a contentious issue as governments consider clean energy strategies, but an analysis of power prices in Europe has now provided evidence to inform the debate.

Vast quantities of wind and solar capacity have been deployed across Europe in recent years. But these power sources are intermittent, generating electricity only when the wind blows or the sky is cloudless.

Gas power plants, which can be switched on and off relatively easily, are frequently relied on to provide power when renewable generation is low. But gas is often the most expensive source of power, and electricity market rules mean the most expensive generator sets the price for the entire market.

That means even when lots of cheap renewables are being used on the grid, using just a small volume of gas power can hugely push up the overall wholesale power price. Across Europe, gas sets the price of electricity around 60 per cent of the time, according to Behnam Zakeri at the International Institute for Applied Systems Analysis in Austria. "Because gas is flexible, it is still needed in high-renewable-energy systems, with wind and solar."

"If you have natural gas, wind and solar, this is the perfect cocktail for you to be vulnerable"

The effect on bills is highest when gas prices soar, as they did in 2021 when covid-19 lockdowns lifted and industrial demand bounced back. Raúl Bajo-Buenestado at the University of Navarra in Spain worked with colleagues to identify why some countries in Europe saw much more dramatic increases in the price of electricity during a spike in gas prices between April and October 2021.

They found that nations with more intermittent renewables – namely wind and solar – in their power systems were more vulnerable to natural gas price shocks. Spain, for example, has large volumes of solar and wind in its system, while Italy has large amounts of solar power. Both scored highly on the power price vulnerability index developed by the team (*Nature Sustainability*, doi.org/n3rf).

The UK wasn't part of the analysis, but its grid, which relies heavily on wind power and gas generation, is also highly vulnerable, says Bajo-Buenestado. "If you have natural gas, wind and solar, this is going to make the perfect cocktail for you to be vulnerable," he says.

It is the need for flexible generation alongside wind and solar that is the issue, says Bajo-Buenestado. He points out that other nations with low-carbon power grids, such as Norway and France, rely on hydropower and nuclear technology, which are reliable generators. "We don't see a clear correlation between decarbonisation and vulnerability to strikes in natural gas prices," he says. "Natural gas is what is making countries more vulnerable."

Solving the problem will require nations to replace gas as the back-up fuel of choice, says Bajo-Buenestado.

One answer is for grid operators to push the power system to become better able to absorb peaks and troughs in generation, says Michael Grubb at University College London. "The underlying message is actually getting a flexible system is now just as important as building renewables," he says.

Technology

Brain implant lets man fly a virtual drone by thought

Matthew Sparkes

A MAN with paralysis who had electrodes implanted in his brain can pilot a virtual drone through an obstacle course simply by imagining moving his fingers. His brain signals are interpreted by an AI model and then used to control the drone.

Brain-computer interface (BCI) research has made huge strides in recent years, allowing people with paralysis to control a mouse cursor and dictate speech to computers by imagining writing words with a pen. But so far, they haven't shown great promise with multiple inputs.

Now, Matthew Willsey at the University of Michigan and his team have devised an algorithm that allows a user to trigger four discrete signals by imagining moving their fingers and thumb.

The anonymous man who tried the technology has lost use of all his limbs due to a spinal cord injury. He had already been fitted with a BCI from Blackrock Neurotech made up of 192 electrodes, implanted in the brain area that controls hand motion.

An AI model was used to map the neural signals received by the electrodes to the user's thoughts. The participant learned how to think of the first two fingers of one hand moving, creating an electrical signal that can be made stronger or weaker. Another signal was generated by the third and fourth fingers and two more by the thumb.

These were sufficient to allow the user to control a virtual drone by thought alone, and with practice, he could skilfully pilot it through an obstacle course (*Nature Medicine*, doi.org/g82h63).

Flying the virtual quadcopter was a shared goal with the participant, says Willsey. "For him, it was the realisation of kind of a dream that he thought was lost once he suffered his injury," he says. "He had a passion and a dream for flying. He would have us take videos and send it to friends." ▮

Environment

Intentionally burning land reduces effects of wildfires

James Dinneen

YOU can fight fire with fire, even in the flammable forests of the western US. According to an analysis of California's record-breaking 2020 fire season, intentionally burning land can reduce the severity and amount of smoke from wildfires that burn those areas later on, even when accounting for smoke from the intentional fires.

14%

less smoke was generated if a wildfire hit a pre-burned area

"We show that there is a net benefit," says Makoto Kelp at Stanford University in California.

The idea of "prescribed burning" isn't new. For millennia, Indigenous societies in California set fires to manage vegetation. But centuries of fire suppression efforts that followed European colonisation have led to forests filled with unburnt vegetation. Heat and drought from climate change have further primed these forests to burn in ever-larger blazes. Now, fire officials in the western US are increasingly looking at prescribed burns to limit wildfires and their smoke.

To see how prescribed burns would work in California's forests, Kelp and his colleagues looked at satellite images of fire severity and smoke from 186 areas where prescribed burns took place, which were later burned during California's 2020 fire season.

They found that, on average, wildfires were around 15 per cent less severe in areas that had prescribed burns compared with nearby areas that hadn't been treated. These pre-burned areas also generated about 14 per cent less smoke, even after factoring in the smoke from the initial prescribed burn.

Setting these strategic blazes was also more effective than other fuel-reduction methods, like mechanically thinning out forests. That is mainly because the intentional burns clear out more of the fine fuel, says Kelp.

Based on these results, the researchers estimate that intentionally setting fire to 400,000 hectares (1 million acres) of California each year would lead to a net reduction in wildfire smoke of around 650,000 tonnes over the next five years, assuming most of that area was burned again within eight years (EarthArXiv, doi.org/n3zk). That is equivalent to cutting wildfire smoke from the state's 2020 season in half.

Claire Schollaert at the University of California, Los Angeles, says this work could help address "valid air quality-related concerns" around the state's efforts to expand prescribed burns.

Prescribed burns were conducted on 30,000 hectares in California in the past fiscal year, more than twice as much as usual, and the state plans to scale up again in 2025, treating around 160,000 hectares.

However, even if prescribed burns reduce overall smoke, more work is needed to understand how communities near prescribed burn areas may be affected, says Schollaert. Frequent, low-intensity smoke from prescribed burns may have different health effects compared with infrequent but intense smoke exposure from wildfires.

There are also regulatory, cultural and political barriers to prescribed burning, given the risk of fires growing out of control. "People are afraid of fire, and rightly so," says Kelp.

He says the strategy doesn't work as well in densely populated areas such as those destroyed in the Los Angeles fires last month, where the proximity of people and property makes it more challenging. ▮

A prescribed burn in Healdsburg, California, in 2020

CARLOS AVILA GONZALEZ/THE SAN FRANCISCO CHRONICLE VIA GETTY IMAGES

Conservation

Corals grown from frozen sperm

Cryopreserved sperm could one day help with coral breeding programmes

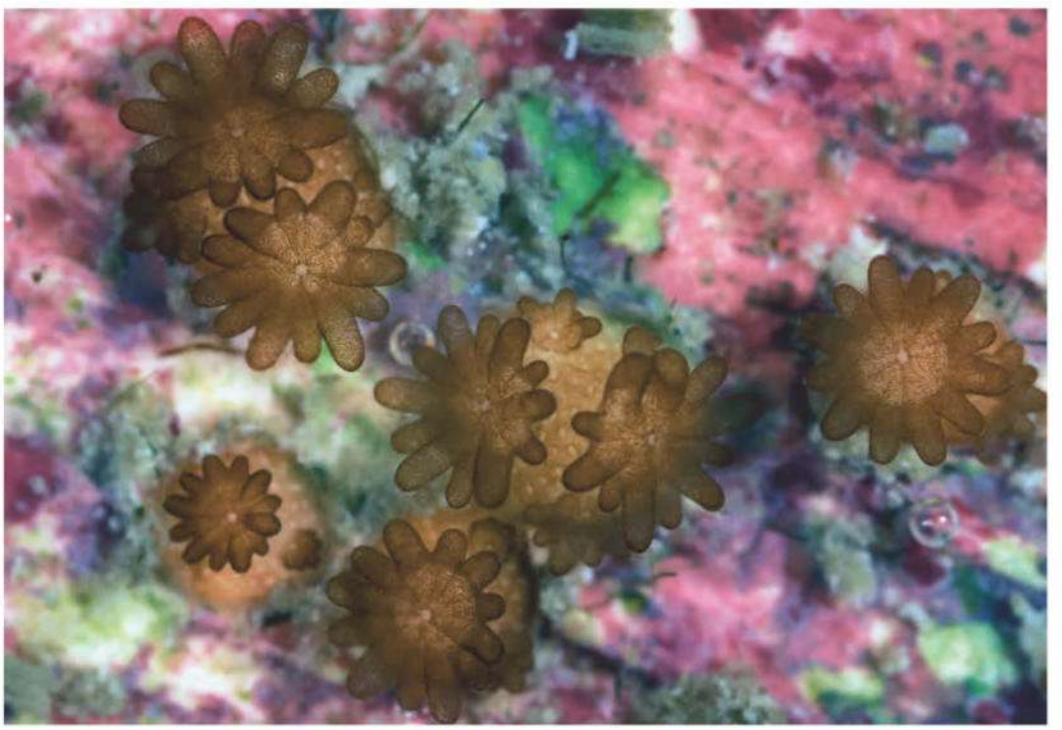
Madeleine Cuff

THIS beautiful image shows juvenile corals grown from eggs fertilised using frozen and thawed sperm.

When corals spawn, they release tiny bundles of eggs and sperm into the water. To become fertilised, each egg bundle must find a sperm bundle from the same species.

A team at the Horniman Museum in London tricked *Acropora millepora* corals into spawning at a specific time and then collected the sperm, before placing it in a deep freeze using a specialised cryoprotectant agent to keep the cells alive during the freezing process. To prove that the frozen sperm could be used to produce living corals at a later date, the researchers thawed and mixed it with freshly collected eggs to create embryos. These grew into juveniles.

Frozen coral sperm and eggs could one day be stored and used to restore reefs should corals die out due to climate change.



DR J CRAGGS/HORNIMAN MUSEUM AND GARDENS

Cosmology

Habitable planets may have formed early on

CONDITIONS in the early universe might have enabled rocky planets with water to form much earlier than anticipated, potentially allowing life to begin sooner.

Astrophysicists studying the early universe think planet formation didn't begin in earnest until supernovae had released enough heavy elements to form planetesimals, the building blocks of rocky planets, around stars. The oldest known planet developed 1 billion years after the big bang.

But Daniel Whalen at the University of Portsmouth, UK, and his colleagues suggest planet formation could have taken place much earlier, just 200 million years after the big bang and before some of the first galaxies started to coalesce.

According to their modelling, planets could have formed around stars smaller than our sun, born from the remains of powerful early supernovae called pair-instability supernovae. These explosions, involving stars hundreds of times the mass of the sun that were the first to form in the universe, could have released enough heavy elements to create planets, the researchers found.

This would have included large amounts of oxygen, which means the discs of matter around the resulting stars could also have contained a considerable amount of water, almost comparable to the amount in our solar system.

"Habitable worlds thus formed among the first generation of stars in the universe, before the advent of the first galaxies," the researchers write in a paper reporting their findings (arXiv, doi.org/n3zj).

"Planet formation could have taken place just 200 million years after the big bang"

Jo Barstow at the Open University, UK, says that if planetesimals were able to form so early in the universe, then there is "no reason to expect there were not any planets". However, their habitability could depend on the presence of gas giants, which might be crucial for limiting the amount of impacts on rocky planets that could render them uninhabitable, as well as for shepherding water-bearing asteroids and comets to such worlds, she says.

"I don't think giant planets could form in that environment" so early in the universe, says Barstow. "I just don't think there's enough material." Whether rocky planets this early in the universe could retain atmospheres, given expected flares and activity from nearby stars, is another open question.

Jonathan O'Callaghan

Climate change

Rock dust alters Earth's reflectivity

Sprinkling crushed rock on fields could increase how much light is reflected back into space

Madeleine Cuff

USING crushed rock dust to speed up the rate at which soils absorb carbon dioxide could also affect the climate by making Earth's surface reflect more or less of the sun's radiation.

Enhanced rock weathering (ERW), as it is known, is rapidly growing around the world as scientists and businesses hunt for ways to capture carbon from the atmosphere. It involves sprinkling crushed volcanic rock, such as basalt, onto soils to accelerate the natural weathering process by which CO_2 in the atmosphere is converted to stable minerals.

But if the practice is scaled up to cover large swathes of land around the world, it could alter the planet's reflectivity, or albedo, according to Brad Marston at Brown University in Rhode Island.

"When I realised that we were talking about millions of square kilometres at least, I realised that even slight changes in albedo could have a big effect," he says.

Albedo is a measure of how much light something reflects, on a scale from 0 (none) to 1 (all). Whiter areas of the planet like the polar ice caps bounce more sunlight back into space, providing a cooling effect, while darker areas absorb more heat and speed up warming.

If the rock dust spread on fields is paler than the existing soil, Earth's albedo could increase, says Marston, boosting the cooling effect from ERW. However, if the dust is darker than the soil, it could have the opposite effect.

Based on mathematical modelling, Marston and his colleague Daniel Ibarra, also at Brown University, estimate that if 1 million square kilometres of agricultural land were spread with crushed rock, it could remove about 1 gigatonne of CO_2 per year from the atmosphere. Yet the impact of the change in albedo could equal or even exceed this, at least in the short term, they conclude. Increasing albedo by just 0.1 on the 48 million km^2 of land used worldwide for agriculture

"Increasing albedo by just 0.1 on all agricultural land would result in Earth cooling by roughly 1°C"

would result in Earth cooling by roughly 1°C, they estimate (arXiv, doi.org/n3rr).

If ERW had a positive impact on Earth's albedo, it could provide a double climate benefit, says Marston, offering long-term cooling thanks to the soil's increased CO_2 absorption and short-term cooling from the albedo change.

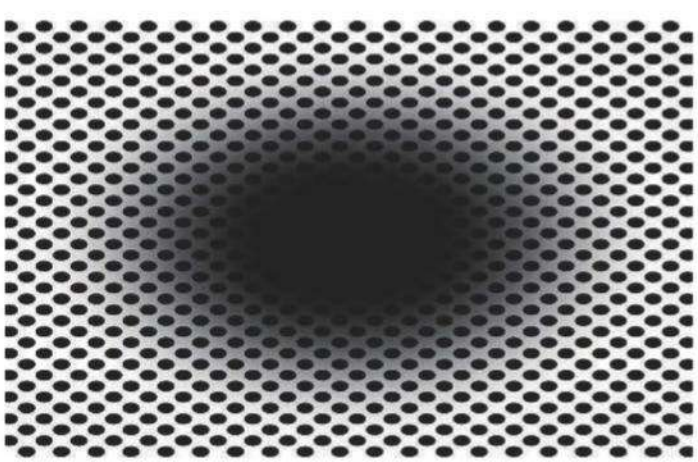
But other researchers aren't convinced ERW could alter planetary albedo. Noah Planavsky at Yale University says most farmers try to minimise the amount of time that soil is exposed. "For most of the year, you have a crop that is totally covering the soil or you have the dead remains of a cover crop," he says. That means Marston and Ibarra may have overestimated the albedo impact of ERW, he says.

David Beerling at the University of Sheffield, UK, doubts the rock dust would change the soil colour for long enough to have an impact. "Even if there was a negative effect on albedo, it would be gone before it had any measurable radiative forcing effect," he says.

Marston says he would welcome further research. "As far as I can tell, this hasn't been considered before, and I think it really needs to be." ▮

Neuroscience

This illusion expands as you stare at it – now we know why



PROF. AKIYOSHI KITAOKA, RITSUMEIKAN UNIVERSITY, JAPAN

Cells called ganglions may explain why you see the black hole in this image expand

THE optical illusion shown here makes the viewer feel as if they are falling into an expanding hole – and now we have a good explanation for why this happens.

Optical tricks can be caused by different elements of our visual and neural systems, even when the effects are similar. To investigate whether the expanding hole illusion begins in the eye, rather than the brain, Nasim Nematzadeh and David Powers at Flinders University in Adelaide, Australia, created a computer model of cells in the retina. Specifically, they looked at ganglion cells, which detect contrast and help adapt what we are seeing by lowering the brightness of very bright regions or increasing it for very dark ones.

Ganglion cells work by signalling to the brain that a certain region is dark or light, but they also send signals to neighbouring cells. The model suggests it is this effect that creates the expanding hole illusion: certain ganglions perceive the dark centre of the image, and they trigger nearby cells to report a darkness even when they perceive an area just outside it, giving the illusion that the dark centre is larger than it actually is (arXiv, doi.org/n3rk).

In addition, different types of ganglion cells are affected by smaller or larger numbers of neighbours, with smaller ganglion cells lying towards the centre of the retina and thus the centre of the illusion. The result is numerous confusing messages being sent to the brain, tricking us into perceiving change and motion where there is none.

Jolyon Troscianko at the University of Exeter, UK, thinks this could help us understand the patterns that we see in nature, such as zebra stripes and butterfly wing patterns, which are often poorly understood. ▮

Matthew Sparkes

Palaeontology

Giant sloths lived alongside people in South America before extinction

Taylor Mitchell Brown

SEVERAL extinct large animals, such as giant sloths, survived in South America much later than previously thought, raising questions about why they died out.

South America was once home to many larger animals, including sabre-toothed cats and sloths that weighed over 4 tonnes. It is widely thought that these animals went extinct around 11,700 years ago – the start of the Holocene – when Earth's climate got warmer and human populations started to expand around the world. But there is no scientific consensus about what caused this extinction, says Fábio Henrique Cortes Faria at the Federal University of Rio de Janeiro, Brazil.

"Modern humans created pressures that many megafauna species could not withstand," says Jens-Christian Svenning at Aarhus University in Denmark. Through hunting and possibly landscape modifications, humans dramatically reduced megafauna biodiversity around the world, he says.

But recent data shows that many extinctions occurred well after the arrival of humans, says Cortes. In the Americas, people coexisted with megafauna for thousands of years. This overlap, along with the survival of heavily hunted species like deer, led Cortes and his team to look for other explanations for the extinctions.

The team used radiocarbon dating to ascertain the ages of teeth from eight Brazilian specimens, including *Smilodon populator*, a sabre-toothed cat; *Eremotherium laurillardi*, a behemoth-sized sloth; the camel-like *Xenorhinotherium bahiense;* and *Palaeolama major*, a large, extinct llama.

MAURICIO ANTON/SCIENCE PHOTO LIBRARY

Large animals in South America went extinct later than expected

This showed that several of these species survived thousands of years beyond previous estimates, pushing their extinctions far past the first appearance of *Homo sapiens* in South America. Most of these animals were still alive around 6000 to 8000 years ago. Two species, *P. major* and *X. bahiense*, survived until 3500 years ago, making them the last known surviving megafauna of South America (*Journal of South American Earth Science*, doi.org/n3q7).

3500

The last known surviving megafauna in South America lived this many years ago

Cortes's team argues that South American extinctions were largely due to environmental factors. The Holocene brought changes in climate that expanded forests and contracted savannahs, which drastically reduced the habitat large animals needed to survive. While human hunting probably also contributed to the decline, it wasn't the leading factor, says Cortes.

However, Svenning says the findings are consistent with the idea that pressures exerted by growing human populations caused the extinctions. While he agrees that environmental factors might have played a role at local levels, he argues that the new data fits well with findings that some megafauna survived into the Holocene in Asia.

"This paper suggests the interplay between human activities and climatic and environmental changes was critical in driving the demise of the megafauna," says Suresh Singh at the University of Bristol, UK. "So, while humans are not solely to blame, we're not off the hook." ▮

Transport

Electric cars now last as long as petrol and diesel counterparts

Matthew Sparkes

ELECTRIC vehicles have caught up to the lifespans of petrol and diesel alternatives – and their improving reliability outpaces that of fossil fuel-powered cars each year as the technology continues to mature.

Robert Elliott at the University of Birmingham, UK, and his team analysed nearly 300 million records from the UK's compulsory roadworthiness test, called the MOT, which show the condition, age and mileage of vehicles on the road between 2005 and 2022. This covered some 29.8 million vehicles.

They found that EVs now have an average lifespan of more than 18.4 years, outlasting the average diesel vehicle at 16.8 years and almost matching the average petrol vehicle at 18.7 years. The average EV now covers 200,000 kilometres during its lifetime, surpassing the 187,000 km of petrol counterparts but falling short of the 257,000 km that diesels reach on average (*Nature Energy*, doi.org/n3q5).

The figures also show that long-term reliability is improving: the likelihood of an EV failing and ending up on the scrapheap in any given year is declining around twice as fast as it is for petrol vehicles and about six times as fast as for diesels.

"The early electric cars were not so good and they were not so reliable," says Elliott. "But the main point, I think, is the technology is improving very rapidly. Electric cars and the batteries, they're just living longer, and the technology is improving, and it would have improved again since this study."

Although the MOT data doesn't include information about how much maintenance and repair vehicles require between tests, only their overall lifespan, research from the US has shown that maintenance costs for electric cars are around $0.06 per mile, while for internal combustion engines the figure is $0.10 per mile. ▮

Botany

Orchid has a fail-safe way to pollinate itself

Sofia Quaglia

IKEDA TETSURO

The *Stigmatodactylus sikokianus* orchid lives in shady Japanese forests

A SPECIES of fungus-eating orchid has an ingenious self-pollinating method. The secret lies in the plant's mysterious finger-like appendage.

"I knew there had to be more to it than just an odd-looking quirk," says Kenji Suetsugu at Kobe University in Japan.

Suetsugu has long been fascinated by the *Stigmatodactylus sikokianus* orchid because it lives in shady Japanese forests and feeds on soil fungi, rather than relying on photosynthesis. The orchid also has a little finger-like projection under its stigma, the sticky part that receives pollen during mating.

To investigate the appendage's purpose, Suetsugu observed the flower in the wild, set up pollination experiments in the laboratory and tracked changes in the orchid's flower structure with fluorescence microscopy.

He noticed that if no insects visited the orchid to pollinate it, the flower started wilting. As it drooped, the finger-like appendage gradually moved towards the stigma, bringing pollen into contact with the sticky receptor (*Plants People Planet*, doi.org/g82t33).

The appendage thus acts "like a bridge", says Suetsugu, transferring the orchid's pollen in a self-pollination trick, but only as a last resort. The wilting mechanism allows a plant to hold out for a pollinator but acts as a fail-safe, ensuring it can still reproduce even if an insect never arrives. The discovery "underscores how nature can come up with really creative solutions to common problems", says Suetsugu.

The next step would be removing the appendage completely to see how much of a difference it makes in pollination timing and efficiency, says Katharina Nargar at the Australian Tropical Herbarium.

While this appears to be the first time this self-pollinating method has been formally documented, Nargar notes that observations from the early 1990s suggest two other closely related orchid species also use their unusual appendages to self-pollinate. ▮

Health

Weight-loss drugs lower risk of 42 conditions

Carissa Wong

DRUGS like Ozempic, called GLP-1 agonists, carry more benefits than risks when taken for their approved uses, according to an analysis of their effects on 175 conditions. The same may not be true for people taking the drugs for other uses, however.

"In this new land of GLP-1, we wanted to really map the benefits and risks for all conditions that might be plausibly linked," says Ziyad Al-Aly at Washington University in St Louis, Missouri.

The drugs are best known for helping people control type 2 diabetes and treating obesity. They mimic a hormone in the body, GLP-1, that lowers blood sugar levels and makes people feel fuller for longer. Dozens of studies suggest GLP-1 agonists may also cut the risk of other conditions, from heart disease to dementia.

To investigate further, Al-Aly and his colleagues examined the health records of more than 200,000 people with diabetes who took GLP-1 agonists in addition to their standard treatment over a four-year period. They also looked at 1.2 million people with diabetes who only received standard care across the same period, and assessed the risks of both groups developing 175 different health conditions.

"People with diabetes who took GLP-1 agonists had a lower risk of heart attack"

The team found that those who took GLP-1 agonists had a lower risk of 42 conditions. For instance, their risk of heart attacks was reduced by 9 per cent and their risk of dementia dropped by 8 per cent. The odds of this group having suicidal thoughts or substance-use disorders also decreased by around a tenth – even when the team accounted for factors that could affect the results, such as participants' age, sex and income levels (*Nature Medicine*, doi.org/g82hpt).

There were downsides for the people taking GLP-1 drugs, however. They were more likely to experience known side effects including nausea and vomiting, along with others not described before. These include a 15 per cent higher risk of kidney stones and more than double the risk of an inflamed pancreas, or drug-induced pancreatitis. In total, there was a higher risk of 19 conditions.

Why these drugs affect such a wide range of conditions is still unclear. "They're reducing obesity, which is sort of the mother of all ills – you treat it and subsequently get benefit in the heart, the kidney, the brain and everywhere else," says Al-Aly. They also dampen organ-damaging inflammation and seem to target parts of the brain related to addiction, he says.

Overall, the research provides reassurance that the benefits of GLP-1 agonists outweigh the risks, at least for people with type 2 diabetes and obesity. "There are no red flags for this group," says Stefan Trapp at University College London, who has worked with an obesity-drug firm.

But for those without these conditions, such as people without obesity buying the drugs to lose weight, the picture may differ. "We have no idea if the benefits will outweigh the risks," says Daniel Drucker at the University of Toronto. ▮

Space

Icy balls may be a new kind of star

A pair of weird objects in space are unlike anything we have seen before

Alex Wilkins

TWO strange, icy objects in our galaxy are so different to anything astronomers have ever seen that they could be a new kind of star.

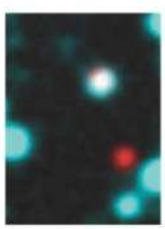
In 2021, Takashi Shimonishi at Niigata University in Japan and his colleagues spotted what appeared to be two icy balls of gas in roughly the same patch of sky, but separated by a large enough distance to be unrelated to each other.

The objects' properties were baffling. They looked like either dense gas clouds or some sort of young star, but they appeared to be isolated from other gaseous or star-forming regions, raising questions of how they might have formed.

Shimonishi and his colleagues found the objects using data from the Japanese AKARI space telescope, which scanned the Milky Way in infrared light from 2006 until 2011. But this didn't have enough resolution to clearly separate which wavelengths of light had which energies, making it even harder to tell what these things were.

Now, the team has examined the objects with a much more powerful radio telescope, the Atacama Large Millimeter/submillimeter Array (ALMA) in Chile. But they still don't look like anything astronomers have seen before. "We tried our best to reproduce the properties, but currently we cannot find any theories that can explain the spectral energy properties," says Shimonishi.

The ALMA observations revealed that the objects must be relatively small compared with other gas clouds, between the size of our solar system and 10 times larger, and are composed of carbon monoxide and silicon monoxide (arXiv, doi.org/n3n4). The high amount of silicon compared with carbon observed is normally associated with violent cosmic explosions, such as a young star blasting out material, but in this case their small size, isolation and abundance of ice don't match up with other known star types, says Shimonishi.



TAKASHI SHIMONISHI/NU

One of the peculiar icy objects (red), as seen by the ALMA radio telescope

"It's a fascinating piece of work, albeit rather puzzling," says Jane Greaves at the University of Cardiff, UK. "The two objects seem to have contradictory characteristics, being cold enough to have abundant ice, but also infrared emission like a star."

One of the more exciting options for what the objects could be is a new kind of star, says Greaves. But to improve our understanding of them, we first need to better differentiate the two objects, as it isn't currently clear how similar they are, she says.

"It's a bit odd that only two of these things have been found and they are both very close in the sky to one another, while at very different distances," says Thomas Haworth at Queen Mary University of London. "It would be interesting to perform a wider survey to see if more of these objects are discovered."

Shimonishi and his team have applied for time using the James Webb Space Telescope (JWST) to make further observations. "JWST is very sensitive and has a high spectral resolution, so we can do a very detailed analysis of ice or dust, which can help us understand the thermal history of the source," says Shimonishi. ▮

Geology

Megaflood shaped Sicily as it refilled the Mediterranean Sea

JUMBLED deposits of rock found on the top of hills in Sicily were left by the megaflood that refilled the Mediterranean Sea 5 million years ago – the largest known flooding event in Earth's history.

The rock deposits and eroded hills in this part of the Italian island are the first land-based evidence for the megaflood, says Paul Carling at the University of Southampton in the UK. "You can actually walk around and see it," he says.

Around 6 million years ago, the Mediterranean Sea was cut off from the Atlantic Ocean and began to dry out. Sea level may have dropped by a kilometre or more.

KEVIN SCIBERRAS/NEIL PETRONI

Rising waters made hills in Sicily more streamlined in shape

Water once again started flowing into the Mediterranean around 5.3 million years ago. It was initially thought that an enormous waterfall near Gibraltar refilled it over a period of tens of thousands of years. But in 2009, the discovery of a massive eroded channel in this area pointed to a much more abrupt megaflood.

Team member Giovanni Barreca at the University of Catania in Italy, who grew up in south-east Sicily, suspected the island was also shaped by the megaflood. So he and his team took a closer look.

Sure enough, they found that jumbled deposits near the top of some hills contain rocks that have been eroded from much deeper layers and carried upwards (*Communications Earth & Environment*, doi.org/g82qj8). "You can tell from their nature that they were from these lower levels," says Carling. "And they were carried up and over these hills."

Many of the hills have a streamlined shape. "They're quite distinctive," says Carling. "And the only thing that can streamline features of this scale is very large-scale, deep flooding."

The team estimates that peak floodwaters flowed at around 115 kilometres per hour and covered the tops of the hills – which are around 100 metres above the modern-day sea level – with about 40 metres of water.

Modelling suggested the entire Mediterranean Sea refilled in two to 16 years, says Carling, but the flooding in Sicily probably lasted only days. ▮

Michael Le Page

Physics

Extremely cold atoms defy entropy

Some atoms can resist the laws of physics when their quantum properties are controlled

Karmela Padavic-Callaghan

THE laws of physics assert that an organised system will grow increasingly disordered over time until it dissolves into featureless mush – but a new experiment shows that some extremely cold atoms could avoid such entropy.

Any system beginning with low disorder, or low entropy, is bound to eventually become more of a mess. Picture flowers arranged in a bouquet: their entropy will gradually keep increasing until the brightly coloured bundle breaks down into brown dust.

For more than a century, physicists believed the process behind this, called thermalisation, was unavoidable. But in the 1950s, it became clear that quantum effects can cause exceptions.

Luheng Zhao at Duke University in North Carolina and his colleagues discovered that such exceptions could be selectively created. In their experiment, some atoms thermalised, while others defied entropy and remained close to their original state. "This has been postulated and conjectured in the past, but never observed in an experiment," Zhao says.

He and his colleagues focused on atoms of rubidium, which they cooled to only 19 millionths of a degree kelvin above absolute zero by hitting them with lasers and electromagnetic fields. They used the same tools – lasers and electromagnetic fields – to arrange up to 19 such atoms into a chain.

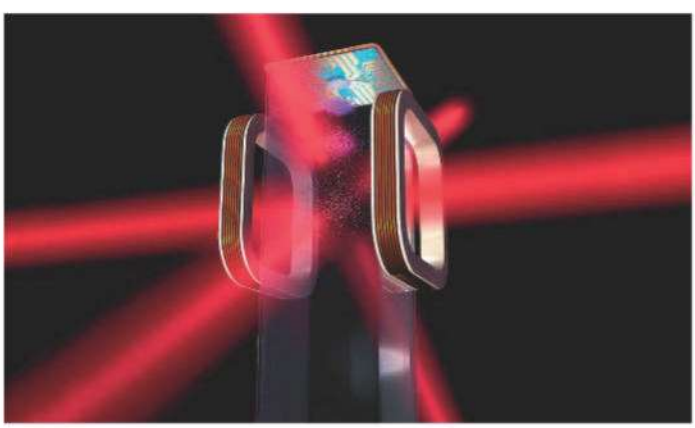
These atoms were also supersized in diameter, meaning their electrons orbited their nuclei at a large distance. As a result, the atoms were extremely sensitive to light, which could then easily be used to control them.

Using laser light, the team could make the atoms interact with each other in a very specific way. Light also allowed the team to precisely set the atoms' quantum properties, such as the energies of their electrons, at the beginning of the experiment. After establishing the initial conditions, the researchers gave the atoms time to naturally change states – an opportunity to thermalise – before measuring those quantum properties and determining the atoms' eventual state.

Strikingly, with the right combination of initial properties and interactions, some atoms in the chain resisted thermalisation. Instead of joining their neighbouring atoms in forming one state that would experience lots of entropy, they ended up with properties very similar to those they had at the start of the experiment. The work will appear in *Physical Review X*.

Thomas Iadecola at Iowa State University says it is unusual for part of a system to somehow fail to reach the same high-entropy state as the rest of it. "Typically, whatever initial state you started in shouldn't matter," he says.

The ability to selectively avoid thermalisation could enable quantum computers built from ultracold atoms to catch and correct their own errors, says Zhao. In this case, the researchers would try to ensure that any malfunction stayed confined to only a few atoms instead of spreading through the whole computer. ▮



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A magnetic and optical trap used to cool atoms close to absolute zero

Geology

Strange structures deep within Earth are truly ancient

TWO huge masses lurking in Earth's mantle may be billions of years old, according to an analysis of seismic waves ringing throughout the planet.

"When there is a big earthquake, the whole Earth will expand and contract like a bell," says Arwen Deuss at Utrecht University in the Netherlands. "Earth becomes a musical instrument."

Decades ago, measurements of such seismic waves identified two strange continent-sized structures, one beneath the Pacific Ocean and one beneath Africa. They extend nearly 1000 kilometres up from the outer core into the lower mantle, a slow-moving layer between Earth's crust and core. As seismic waves pass more slowly through them, they are called large low-shear-velocity provinces, or LLSVPs. But not much else about them is known.

To find out more, Deuss and her colleagues analysed how the LLSVPs dampened the energy of seismic waves, in addition to changing their velocity. This can reveal information about their temperature and makeup, as well as their shape and size.

The team expected to find that the structures – which are thought to be hot relative to surrounding areas – would significantly dampen seismic waves. "Lo and behold, we found the opposite," says Deuss.

To explain the lack of dampening, even at high temperatures, the researchers propose the LLSVPs must be made up of minerals with large crystals that could remain stable in the heat (*Nature*, doi.org/g82s8k). This would also suggest they are highly viscous and could maintain stability even as the mantle moves around them.

"These two objects are extremely old, possibly dating to the formation of our planet"

That stability may mean these objects are extremely old, with origins going back at least half a billion years and possibly even to the formation of the planet more than 4 billion years ago, says Deuss. They may serve as reservoirs for primordial material, unchanged since Earth took shape, that could reach the surface via volcanoes. ▮

James Dinneen

Space

Scorching supersonic winds swirl on alien planet

Alex Wilkins

A VAST alien planet has blistering winds racing around its equator at nearly 30 times the speed of sound on Earth.

Lisa Nortmann at the University of Göttingen, Germany, and her team were observing WASP-127b, a giant gas exoplanet more than 500 light years from Earth. It is slightly larger than Jupiter and is one of the least dense planets we know of.

The team expected to see one signal in the spectrum of light from the planet's atmosphere, but instead found two separate ones.

"I was a little bit confused," says Nortmann. "But with a little bit more careful data analysis, it became clearer that there are two signals. I was quite excited – my first thought was immediately that it has to be some sort of super-rotating wind."

The researchers concluded that the two peaks came from rapid winds in a jet stream around the planet's equator, with half the wind moving towards Earth and the other half moving away from it. The wind, which appears to be made up of water and carbon monoxide, seems to be moving at 33,000 kilometres per hour, making it the fastest wind ever measured on a planet (*Astronomy & Astrophysics*, doi.org/n3g2).

"We're talking about 9 kilometres per second. The wind speed on even Jupiter is like a few hundred metres per second, so this is really an order of magnitude larger," says Vivien Parmentier at the University of Oxford.

You wouldn't be able to feel these extreme speeds if you were in this wind, because everything would be moving at the same speed, he says. But you would experience temperature differences of hundreds of degrees over a matter of hours, as the winds moved from the hot side of the planet, which is permanently facing its star, to its cold side, which sits in constant darkness. ▮

Green tech

Vertical solar panels generate electricity while helping crops

Madeleine Cuff

NEXT2SUN AG

The solar panels acted as windbreaks for crops

RAPID reductions in the price of solar panels mean they are starting to appear in unexpected places, from balconies to motorway embankments. Now, researchers say they could play the role of hedgerows in farm fields, with double-facing solar panels generating power while acting as windbreaks for crops and livestock.

Farmers are already installing solar panels, often positioning tilted arrays over crops or allowing sheep to graze between panels. But such installations, known as agrovoltaics, can lead to excessive shading of plants or limit the land available for food production.

Marta Victoria at Aarhus University in Denmark says one solution could be to place two-sided panels in vertical rows in fields.

Placing panels vertically leaves maximum field space clear for farming, while allowing solar generation during the morning and evening if the panels face east and west. This orientation also avoids shading the plants when the sun is at its highest.

"We know that solar [photovoltaics] is becoming cheaper and cheaper, so it makes sense to start thinking about new ways of using solar panels," says Victoria.

In Denmark, it is common for trees, wooden fences and even plastic sheets to act as windbreaks for crops. "We thought, if we are going to do this, why not make these wind shelters produce electricity?" says Victoria.

3 metres
Height of the vertical solar panels tested

Together with colleagues, she conducted a year-long pilot study involving a 44.4-kilowatt system of double-faced solar panels in a field of winter wheat and grass clover, to assess the effect on crop yield. The panels had a 50-centimetre gap above the ground and rose to 3 metres in height.

The team found the vertical panels reduced average wind speeds over the crop field by around 50 per cent compared with a control field with no panels (Research Square, doi.org/n3nr). The panels also helped to maintain humidity in the field compared with the control field, and there was no reduction in crop yield overall, says Victoria.

The panels generated much less electricity than a standard tilted array, but it was produced in the mornings and evenings. "It matches better when there is high electricity demand in the system," says Victoria.

Next2Sun, a German tech firm, has already developed a number of commercial vertical agrovoltaic projects across Germany, and even produces "solar fencing" for farmers. But Victoria's research, which hasn't yet been peer-reviewed, is one of the first to specifically assess the impact of this setup on crop yield.

Greg Barron-Gafford at the University of Arizona says vertical panels could work well at higher latitudes, when the sun is lower during winter seasons. He stresses that the research is still at an early stage, with more work needed to assess the performance of the system during extreme weather and with different crop types.

Crops 50 centimetres and higher could be shaded by the panels, he says. But for some high-value crops, such as grapevines or berries, the system could work well. "There's going to be a way forward that brings renewable energy and agriculture together," he says. ▮

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The tap that does it all

The columnist
Graham Lawton on reintroducing lynx to the UK p22

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Dramatic shots of SpaceX's Starship disintegrating p24

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Why extending more rights to animals is a moral imperative p26

Culture
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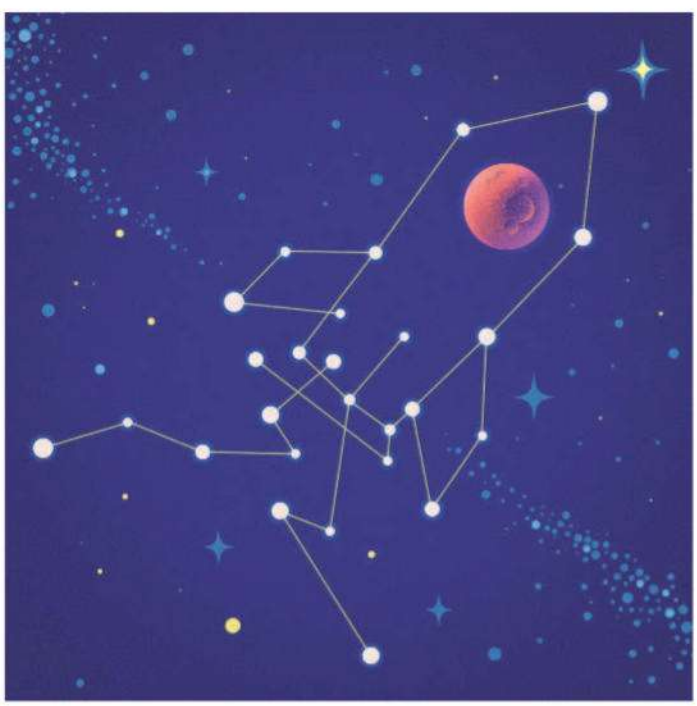
Will Musk become the first emperor of Mars? p29

Comment

Boldly attempting to go

Scientists' ideas for interstellar spacecraft range from the wholly improbable to the wildly expensive and very difficult, says **Ed Regis**



ADRIÀ VOLTÀ

WHILE researching *Starbound*, my new book on the realities of interstellar travel, I was often surprised by the bizarre, over-the-top spacecraft designs that scientists have proposed in well-regarded academic journals. The best-known of these is Project Orion (1957-1965), whose central idea was to propel an interstellar spacecraft by detonating a series of thermonuclear bombs behind it, giving the craft a succession of powerful kicks through space.

Long after the project ended, Freeman Dyson, who worked on the project, said: "We really were a bit insane, thinking that all these things would work." Amen.

Plenty of other wild starship designs have been offered up, in all seriousness. In 1984, Anthony Martin stated in the *Journal of the British Interplanetary Society* that "the carrying capacity of the largest vehicles proposed is only some 50 million (that is, equivalent to the population of the British Isles)". Only?

That same year, physicist Robert L. Forward published a design for a laser-pushed, 1000-kilometre-diameter interstellar light sail. This, he admitted, had a major drawback: "If we want to provide a constant acceleration, the laser power would have to be increased from 43,000 TW at the start to 75,000 TW or more at the end of the acceleration phase." "TW" stood for terawatts – at that point, 1 terawatt was the total amount of power produced on Earth in one year. By any standard, 75,000 is a lot of terawatts.

In 1996, NASA engineer Thomas McKendree revealed what might be possible if molecular nanotechnology were used to build a spacecraft from material structures made out of diamond. This would allow for a 4610-kilometre-long ship. The habitable area inside it, he wrote in a paper, "yields a possible population for this structure of 99 billion people". (Why not just round up to 100 billion?)

But even more modest designs turn out to probably be unworkable in practice. One of the most popular ideas at present is the "world ship", in which generations of passengers are born and die aboard a spacecraft over hundreds of years of travel. In 2020, Andreas Hein at the University of Luxembourg and his colleagues published a paper defining these craft as "starships with populations of over 100,000 and a velocity below 10% the speed of light".

A spaceship with 100,000 people on board is, by itself, an epic, even heroic, design concept. Its construction would require resources on a scale never before seen on Earth. The authors say the major stumbling block of such a design concerns its consistent operation over time: "World ship reliability is likely to be a major feasibility issue, due to the large number of parts and the long mission duration."

The researchers estimate a failure rate of three component parts per second. Keeping up with this would require a large and autonomous repair capability. Since the facility would also be subject to failure, it must be self-repairing. But the catch is that such a self-repairing system would itself be susceptible to the breakdowns it was designed to prevent or repair. So, in the end, the world ship becomes a self-destructive artefact, one that effectively dooms the craft and its passengers. Surprise!

Even if interstellar travel is out of our reach for the indefinite future, the fact remains that we have the rest of our own solar system to colonise. Possible destinations include the moon and Mars, as well as satellites like Europa and Enceladus. Another option would be to create space colonies in Earth orbit or among the asteroids. Colonising any of these places would be a huge engineering challenge and wildly expensive. But the best thing going for this option is that, while difficult in practice, it isn't preposterous. ▮

Ed Regis's latest book is *Starbound: Interstellar travel and the limits of the possible*

No planet B

A cat in hell's chance? Reintroducing predators like the lynx sounds wonderfully romantic in principle, but there are hoops to jump through first, learns **Graham Lawton**

Graham Lawton is a staff writer at *New Scientist* and author of *Mustn't Grumble: The surprising science of everyday ailments*. You can follow him @grahamlawton

Graham's week

What I'm reading
I'm learning to play bridge, so Begin Bridge *by G. C. H. Fox. Mind-boggling stuff.*

What I'm watching
I thought I'd had my fill of The Traitors *(BBC), but the new season is compelling.*

What I'm working on
Tackling my fibre intake for a bit of self-experimentation.

This column appears monthly. Up next week: Annalee Newitz

FOR the past couple of years, I have had the pleasure of hosting *New Scientist*'s rewilding weekender at Coombeshead, a farm in Devon, UK, that is being magnificently returned to nature. At the end of this two-day trip for paying guests, we hold a straw poll on which large mammal the audience would like to see reintroduced to Britain. Both times there has been a hands-down winner: the lynx.

I was reminded of this when news broke in January that four Eurasian lynx had been spotted – and later captured – in the Cairngorms National Park in Scotland. There is a very active project aimed at reintroducing lynx into the UK and, if it gets the go-ahead, that area could be where the big cats are released first.

I was under the impression that lynx would take to the Cairngorms like ducks to water, ghosting into the forests and living largely unseen, eating deer and troubling nobody. Indeed, there are rumours that these big cats are already present, having been re-introduced illegally by guerrilla (surely wildcat?) rewilders. But the Cairngorms four were easily captured and appeared totally ill-equipped to live in the wild. One died soon after it was found. It still isn't clear how they got there; maybe they were exotic pets abandoned by their owner.

Soon afterwards I went to Cambridge to attend the Citizen Zoo 2025 Rewilding Conference. By coincidence, one session was on lynx reintroduction in the UK. This has relevance to other predator rewilding efforts around the world, including Iberian lynx and – just possibly – the thylacine, or Tasmanian tiger, in Australia, should de-extinction be possible for that species. It turns out that reintroduction is much more complicated than I had thought. I still think that lynx would be a fantastic re-addition to the UK's wildlife after being absent for at least several centuries, but the romantic notion that they could be brought back tomorrow with no problem is for the birds.

Efforts to get this cat living there again is being led by rewilding charity Scotland: The Big Picture. Hugh Webster, whose job title at the body is lead storyteller (what a great role!), told the conference that while the Cairngorms are ecologically suitable for lynx and vice versa – there is ample habitat and food for roughly 250 – there are still many hoops to jump through before they can get paws on the ground. The most important and difficult one is to get the general public on board.

> **"There is ample habitat and food in Scotland's Cairngorms for a population of roughly 250 lynx"**

Last year, the charity started a consultation. It found that while there is majority support in Scotland for the return of lynx, resistance remains. "There is still a significant number of people who either oppose it or strongly oppose it and... a lot of people in that group are key stakeholders in the areas where we're looking at reintroducing lynx," Webster told the conference.

The strongest pushback comes from sheep farmers. Lynx prefer to eat roe deer, but will take livestock. "There is no question that lynx can and do kill sheep, sometimes in quite high numbers," said Webster. The charity will have to persuade farmers that the risks can be managed and that there are compensation schemes in place. But it is a tough sell. Had the four lynx in the Cairngorms killed even one sheep, then the next round of consultation would have been dead in the water, he said.

Foresters, too, are jumpy. In principle they are in favour. Scotland is overrun with deer, which can feed on and damage trees, and lynx kill a lot of deer – one of the compelling ecological reasons for reintroducing them. But foresters are afraid of yet more legislation. They already have to do expensive, time-consuming surveys to check for the Scottish wildcat, and operations cease if any are present. If the same applied to lynx, that could be the last straw.

There are other unknowns and concerns. Reintroducing lynx may be the final nail in the coffin for the capercaillie, a type of oversized grouse that is already endangered and in steep decline. But on the other hand, it could help them by curbing the number of foxes, which kill many of the birds. The game bird shooting industry also needs persuading that lynx won't gobble up or scare off its stock.

As for the notion that lynx are already in the Scottish Highlands, forget it. Webster told me there is no way they could go undetected. There are so many people doing ecological surveys there, and so many camera traps, that the animals, or their kills, would be seen. "We'd know," he says.

So when might lynx return? If the charity can win over objectors, the next step is for it to apply for a licence to release 20-plus lynx on a trial basis. That could be in as little as 12 months. But I am sorry to say that I don't think there is a cat in hell's chance of it ever happening.

Meanwhile, I will watch with interest the ambitious plan by US company Colossal Biosciences to resurrect the thylacine. ▮

Events

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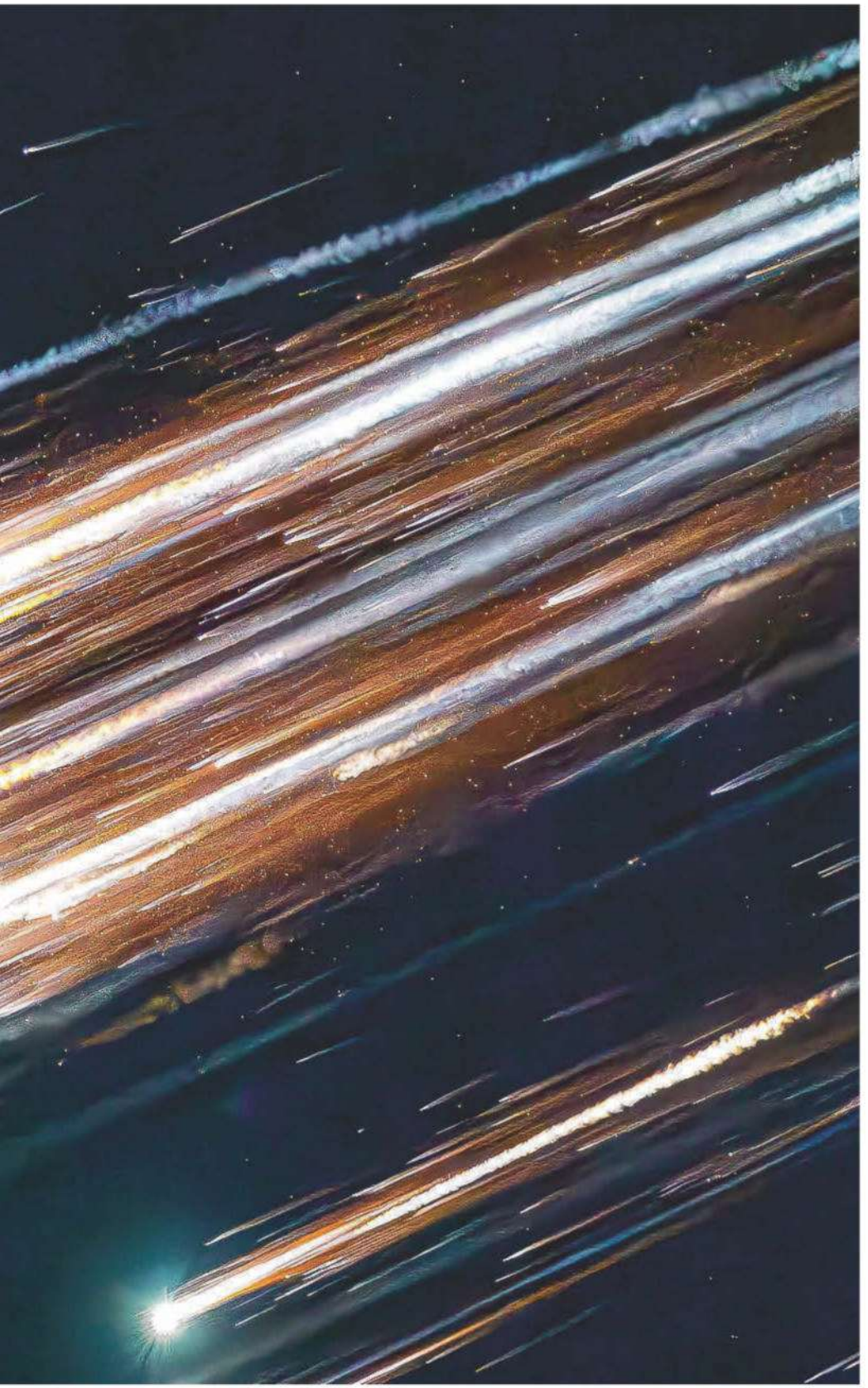

Burning up

Photographer James Temple

THESE eerie images of a fiery sky show the moment when SpaceX's Starship rocket dramatically returned to Earth in pieces last month. They were captured by photographer James Temple, who was working as a chef on a superyacht in the Turks and Caicos Islands. When he realised what was happening, he grabbed his camera extender for a closer shot.

Starship's seventh test flight took off from SpaceX's site at Boca Chica, Texas, on 16 January, but experienced "rapid unscheduled disassembly", as the company creatively refers to explosions, following a fire in the rear section of the ship.

"We were all aware that the launch was taking place, but I didn't expect to witness such a dramatic moment," says Temple. He describes the scene as "almost otherworldly, reminiscent of something from the extinction of the dinosaurs".

While plenty of video exists showing the rocket's explosion, Temple's are the only known images shot by a professional photographer. He says it felt "surreal" to have been the one to take them. His other job as a chef meant that he was "in the right place at the right time to capture these images", he says.

Tim Boddy

Human rights for all?

Some animals – and even machines – may turn out to be conscious. Must we wait for scientific certainty before sharing our rights, asks **Michael Marshall**

Book
The Moral Circle
Jeff Sebo
W. W. Norton
US: on sale; UK: March

PETER999/GETTY IMAGES

What does this monkey make of the image in the car mirror?

SHOULD chimpanzees have rights? What about elephants? Or ants? Or microorganisms? And how about artificial intelligence?

These questions are at the heart of *The Moral Circle: Who matters, what matters, and why*, a crisply argued little book by philosopher Jeff Sebo. Based at New York University, Sebo has spent years arguing that consciousness is widespread in the animal kingdom and that we should extend our moral circle to encompass many more types of creature than we do at present. His work builds on that of ethicist Peter Singer, author of the classic book *Animal Liberation*.

Sebo was one of the authors of a legal brief arguing that two captive chimpanzees called Kiko and Tommy should be considered "persons" instead of "things". In April 2024, he was a signatory to The New York Declaration on Animal Consciousness, which said there is "strong scientific support" for conscious experience in mammals and birds, and "a realistic possibility of conscious experience" in many invertebrates, notably insects and cephalopods.

In *The Moral Circle*, Sebo sets out to demonstrate that we should take animal consciousness seriously when we decide how to treat other creatures. The scientific evidence for animal consciousness is growing, from reports of monkeys and dolphins apparently calling each other by "name" to our improved understanding of when animals are (or appear to be) happy, as well as evidence of vivid dreams in octopuses – and even in pigeons.

However, Sebo's aim isn't to convince us that particular species are conscious – that remains scientifically contentious. Instead, he makes a point that is both simple and profound: waiting for absolute certainty is a mistake.

"Extending rights to animals seems very far away. But perhaps we need wider empathy in times like these"

We can never be 100 per cent sure if another being is conscious, even our fellow humans. But most of us still act as if other people are conscious beings with feelings and rights. Right now, we aren't entirely sure whether chimps or elephants are conscious and we are very uncertain about ants – but in all three cases, it is a distinct possibility. That means we must treat them with some degree of moral concern.

This probabilistic argument is both refreshing and commonsensical. It reflects the truth of our experience of animals, and it encourages a degree of kindness and consideration without imposing dogmatic standards. Sebo isn't saying that we should necessarily treat a chimpanzee or an ant as equivalent to a human, but even if we don't, there is plenty of room for us to extend them more care than we do at the moment.

Much of his book is devoted to thought experiments, for instance exploring when it is and isn't permissible to release pollutants into a lake. One fascinating what-if imagines an animal welfare charity that must decide whether to save a small number of elephants or a large number of ants: at what point does the suffering of numerous but "simple" ants equal that of the "complex" elephants? These sections are a workout for your brain, in the best sense: Sebo writes with great clarity, so you can follow the knottiest problems.

Inevitably, he also explores AI consciousness, taking the same probabilistic approach. While there is no good reason to think any existing AI is conscious, there is also no good reason to think AI could never be conscious, so he argues we have to prepare for the possibility that future AIs will be.

My one concern is that Sebo may simply be writing at the wrong time. We live in an age where many of our leaders are trying to take rights away from many people, ranging from transgender people and migrants to women in Afghanistan and Uighur Muslims in north-west China. The prospect of extending rights to animals like chimps and elephants, let alone squids and flies, seems very far away. But perhaps it is in times like these that we need calls for wider empathy most of all. ▮

Michael Marshall is a writer based in Devon, UK

Sticking your neck out

The neck is less than 1 per cent of the human body's surface area, but it plays an oversized role in our lives, finds **Elle Hunt**

Book
The Neck
Kent Dunlap
University of California Press

THE late writer and filmmaker Nora Ephron famously felt bad about her neck. Ephron's concern, as expressed in her best-known essay *I Feel Bad About My Neck*, was ageing, and the neck in particular as a "dead give-away" of the passage of time. The visibility of the area and "the truth" it exposed was cause, for Ephron, to cover up with turtlenecks and scarves.

For Kent Dunlap, a biologist at Trinity College, Connecticut, it called for a closer look. In his first book, *The Neck: A natural and cultural history*, he argues that while the neck is only a small region, connecting head and torso, it is surprisingly central to the human condition. Not only do its muscles control head movements, and with this our attention, it also facilitates our speech and plays its part in providing our brains and bodies with blood, air and food. We adorn it with jewels, fine fabrics and fragrance. It plays a role in courtship rituals, self-expression, status signifying and even in our myths.

Yet the neck's importance is at odds with its essential weakness, from the risk of choking to permanent paralysis or fatal injury. Dunlap begins with Isadora Duncan, the dancer whose swanlike silhouette revolutionised the form in the late 19th century, and who died in 1927 from strangulation after her scarf was caught in the rear wheel of her convertible.

With a tension between "vitality and vulnerability" as his starting point, Dunlap sets out to explore how humans wound up with our type of neck (versus, say, the elongated one of a goose or giraffe) and the remarkably many ways in which it is pertinent to our survival and society.

In his lively account, Dunlap draws on his expertise as a lecturer in physiology and anatomy and wide-ranging sources to shore up his assertion that the neck has an under-acknowledged and "oversized role in our biology, psyche and culture".

But it is his palpable curiosity and enthusiasm for his subject that makes his book so engaging, and even pacy. *The Neck* is so thick with trivia, it is easy to forget that the area itself amounts to less than 1 per cent of the human body's surface area – and even that you are reading a book about necks. The angles that Dunlap finds on his subject are remarkable in their number and variety, yet he never seems to be padding: each inclusion is well argued and proportionately dealt with.

Naturally, Dunlap quotes Ephron as perhaps the only author before him to have expended such time and thought on the neck, and in fact concurs with her point that the area is especially revealing. It is a "reliable reporter" not just of age, Dunlap writes, but other aspects of demographic identity – take the different connotations of an aristocratic ruff or a tattoo. Consciously or not, we continue to judge men by their preferred necktie knot and women on their decolletage.

And in recent years, widespread disquiet about our reliance on technology and time spent on digital devices has manifested as concerns about "text neck". It is true that tilting the head, typically when scrolling on a tablet or smartphone, exerts unusual force on the cervical spine, and may have long-term and even permanent consequences. But these are still emerging, and have yet to be conclusively researched.

It proves Dunlap's point that this small apparent "transition zone" between head and torso can be seen to encapsulate both the strengths and weaknesses of the human species, and the incredible feat of evolution and its odd oversights.

His book may turn heads for its seemingly narrow scope – but it will surely open minds, too. ▮

Elle Hunt is a writer based in Norwich, UK

We adorn the neck with jewels and perfumes, and it plays a key role in human courtship rituals

MARTIN PARR/MAGNUM PHOTOS

New Scientist *recommends*

Madeleine Cuff
Reporter
London, UK

Until recently, my vague idea of the Silk Road, the trade link from ancient east Asia to the West, was of camels crossing deserts laden with silk and spices. But a trip to the **Silk Roads** exhibition

at London's British Museum showed me how little I knew.

There were camels (pictured), but far from being one road, there was a network of routes, moving art, jewels, food, religion and culture. The show, which ends on 23 February, focuses on the period from AD 500 to AD 1000, charting a swashbuckling journey of two-way trade covering Japan, China, North Africa, central Asia and Europe.

The story features gilded Buddhas, striking murals and lavish textiles. And, for the first time, many artefacts have been forensically analysed to reveal their origins. Darker histories are exposed, as slavery's iron manacles contrast starkly with the trade in gleaming necklaces.

Even amid the so-called Dark Ages, the tendrils of globalisation were unfurling, paving the way for the Renaissance.

THE TRUSTEES OF THE BRITISH MUSEUM

Don't bet on human futures

A provocative new book delves into the way humans – and elephants – evolved to manage risk. Our strategy may cost the planet dearly, finds **Simon Ings**

Book

The Gambling Animal

Glenn Harrison and Don Ross

Profile Books

INSIGHTS into animal evolution used to come from studying a creature's evolutionary relationships to its closest relatives. To lampoon this slightly: we once saw humans as a kind of chimp. Our perspectives widened and, looking across ecosystems, we began to see what drives animals who share the same environment towards similar survival solutions. This is convergent evolution – the process by which, say, if you are a vertebrate living in an aqueous medium, you are almost certainly going to end up looking like a fish.

In *The Gambling Animal: Humanity's evolutionary winning streak – and how we risk it all*, experimental economists Glenn Harrison and Don Ross look at this process from an even further remove. They study evolution in terms of risks to a species' survival, and trace the ways animals evolve to mitigate those risks. From this distance, it makes more sense to talk about communities and societies than individuals.

We used to think that social animals thought, at least a little bit, "like us". But this was never more than hand-waving in the absence of good data. Now, Harrison and Ross have real data from their research station in the grasslands of South Africa. They have expanded their focus beyond humans to African elephants, running experiments where they present them with the kind of "risky choices" that are the staple of TV quiz shows. Which door hides the orange? Is it the one that hid an apple earlier? Elephants may choose for themselves, but they are allowed to (and do) confer before they come to a decision.

The pair are working on how elephants think, why they never forget and why elephants and humans acquired such huge, peculiar brains in the mid-Pleistocene Epoch, around 700,000 years ago. This encephalisation – an increase in the complexity or relative size of the brain – suggests they both co-evolved a neurological solution to a challenge: mounting climate unpredictability. They had no choice but to learn how to "gamble" on the likely location of future resources.

But while humans developed an overgrown frontal cortex and learned to imagine, elephants overgrew their cerebellum and learned to remember. For most of evolutionary history, elephants were more successful than hominins. But eventually human imagination led to technologies and hunting techniques that allowed them to outcompete the elephant.

"While humans are mildly risk-averse, our institutions collectivise risk with astonishing effectiveness"

Harrison and Ross are out to write a dense, complex, closely argued exposition of their risk and reward work with humans and elephants, and to discuss the evolutionary implications. This isn't literature, and it may take time to settle to their meticulous style. But treats lie in store for the patient, such as when they speculate about "elephant science" (very statistical, more collective).

So how does a mind (ours) that can't remember more than seven digits for more than 5 minutes ever arrive at an understanding of science? The authors admit that, having worked for so long with elephants, they find humans ever more baffling.

But here's the thing. Tracing how humans evolved to manage risk, from the savannah to Wall Street, they note that while individuals are mildly risk-averse, we innovate behavioural norms – institutions – that collectivise risk with astonishing effectiveness.

The flowering of this may be the idea of limited liability, pioneered in New York state in 1811, which turbocharged runaway growth "across multiple dimensions, particularly of population and per-capita wealth". However much we individually fear the future, our institutions can take horrible chances – not least with climate.

This is an unbelievably high-risk strategy. The direct ancestors of *Homo sapiens* just got lucky, say Harrison and Ross: they won the jackpot of ecological dominance because some large-scale climate change happened at the right pace and in the right sequence.

But past performance is no guarantee of future returns, so the authors are far from optimistic: "The history of humans," they write, "is not a record of safe bets." We might do better to think like elephants, and weigh probabilities rather than dream up might-bes and nice-to-haves. ▮

Simon Ings is a writer based in London

Traders on Wall Street show how institutions can take big risks

SPENCER PLATT/GETTY IMAGES

Editor's pick

Will Musk become the first emperor of Mars?

Letters, 18 January

From Paul Friedlander, London, UK

Reader views on the colonisation of Mars, varied as they have been, have missed the most important point of all. Historically, colonisation was driven by a search for opportunities to trade and get rich. Perhaps, with Elon Musk as one of the chief proponents, we are missing the elephant in the room. Rather than debating the technical dangers and difficulties, would it not be better to speculate about what wild ideas Musk has tucked away in the back of his mind?

Let us start with the working assumption that a man who is already approaching 10 times the wealth Bill Gates accumulated has a good business plan for his colony. But what will it be? That is the question I invite fellow readers to ponder. It may not be pretty, and Musk may well see himself as the de facto future emperor of Mars. One way or another, I am confident there is money to be made, and anyone who doubts that hasn't looked far enough into the future.

We need to burst another quantum bubble, too

11 January, p 32

From Robert Masta, Ann Arbor, Michigan, US

"Bursting the bubble", about quantum ideas that could do away with the multiverse, was excellent, but it is troubling that theorists still consider Schrödinger's cat and Wigner's friend to be valid thought experiments. They assume that a human observer is required for quantum collapse, which is absurd.

How did the universe get along without us for 13 billion years?

Quantum superpositions are so fragile that designers of qubits for quantum computers must go to great extremes to isolate them, yet still they collapse in milliseconds as a result of stray interactions.

Schrödinger and Wigner (and friend) are simply ignorant of the collapse until they peek.

Bananas might boost plants in another way

11 January, p 44

From Jim Moore, Coelbren, Powys, UK

James Wong's verdict on the poor efficacy of banana skins as plant fertiliser was spot on. However, it is likely that the widely reported benefits attributed to banana skins for gardeners are down to their polyphenol content.

It has been shown that an application of polyphenols can act as an antioxidant and increase protein functionality in most plant species. They aren't fertilisers, but work more like catalysts, enhancing certain metabolic activities.

Multiverse worries are multiplying

4 January, p 40

From Jim McHardy, Clydebank, West Dunbartonshire, UK

If quantum computers are accessing the multiverse, as Hartmut Neven suggests, then we must assume that aliens in parallel universes could also have quantum computers. They must also be aware of their making use of other universes' quantum computers. Could this make us lab rats for their experiments?

You can tell a good actor by the way they blink

11 January, p 17

From Steve Archbold, Chichester, West Sussex, UK

The report that blinking gives your brain a break by taking pauses while reading reminds me of the views of Hollywood film editor Walter Murch in his 1992 book *In the Blink of an Eye*.

He says the difference between a good actor and a bad one is in the timing of a blink. A good actor will blink at the point where their character understands what has been said, usually coinciding with the end of a sentence, whereas a poor actor will blink randomly.

There are easier ways to mop up carbon dioxide

4 January, p 22

From Dave Covell, Ottery St Mary, Devon, UK

As an energy/carbon engineer for over 35 years, I fully support the "defossilisation" of production of goods. However, why the fixation on capturing carbon from the flue gas of blast furnaces or other hot and highly polluted sources?

In my career, I have encountered many manufacturing processes, including acid neutralisation and fermentation, which emit streams of inherently clean carbon dioxide at low temperatures, making them much easier to handle. Surely all such sources should be prioritised before we start on more difficult CO_2 capture. The environmental benefit is identical, cost per tonne is lower and therefore the chance of overall success is much higher.

Pessimism can be a valid strategy too

4 January, p 32

Name/address withheld on request

When it comes to optimism, I am a glass-half-empty person and know why. I now recognise that my mother experienced extreme anxiety, particularly in relation to travel. As a child, holidays and trips would be planned, only to be cancelled at the last moment. I learned to temper my excited anticipation. A desire to avoid those negative feelings led me to develop a pessimistic strategy, which I still use: if I expect the worst, then I am not disappointed if it is so, and I experience a great deal of joy and pleasure if things go to plan. This has served me well. It isn't clear to me why I would wish to be an optimist.

On the heat problem of computation

28 December 2024, p 38

From John Theophilus, Bream, Gloucestershire, UK

As I understand it, "Backwards computing" asserted that the bulk of heat emitted by computers arises from changes to information in the process of doing calculations. Does this apply to other media? How about a sheet of paper on which difficult sums had been written?

All-seeing Santa needs to keep a closer eye

14/21 December 2024, p 10

From Jim Ainsworth, Kingsland, Herefordshire, UK

You ask if Santa's festive surveillance brings about an improvement in children's behaviour. A 6-year-old granddaughter was being encouraged to behave particularly well in the run-up to Christmas because Santa is all-seeing. When she encountered actual Santa in his grotto, he, not having been properly briefed, made the mistake of asking her whether or not she had been good. "You should know!" she told him. ▮

For the record

▮ Gremlins got into our bumper word search grid (14/21 December 2024, p 37), with Cetus, gray, Puppis, Crux, Lynx, lux, stratus and naledi affected.

▮ In computing, AND gates are logic gates that output the product of their inputs (28 December 2024, p 38).

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Black holes from nowhere

My conception of "virtual" black holes that hide in the fabric of the cosmos may explain what dark energy is, says **Samir Mathur**

SAM CHIVERS

FOR as long as we have tried to figure out the nature of reality, we have grappled with the concept of empty space. Around 400 BC, when the ancient Greek philosopher Democritus conceived of small, indivisible bodies called atoms, he supposed there must also exist a void surrounding them: a featureless, unchanging vacuum in which they moved.

Today, the void remains a potent idea for understanding the universe, but we have come to realise that it is anything but featureless. More than a century ago, Albert Einstein's theory of gravity revealed that space-time is stretched and warped by the matter it contains. Later, quantum theory introduced the idea of virtual particles, which momentarily appear and disappear in a vacuum, making pure nothingness seem like an intangible, bubbling soup.

This alone would surely have shocked Democritus, but I believe we should go further still. I have spent four decades trying to find a way to combine Einstein's theory of gravity and quantum mechanics. This long journey has led me to a startling conclusion: there is another rich structure hidden within the void, which can be traced to ethereal entities called virtual black holes.

The influence of these stretches across the entire cosmos, linking space-time in subtle ways that ultimately cause Einstein's theory to fail – forming a bridge between the smallest scale of the quantum realm and the cosmic one of gravity. Enticingly, I have now begun to grasp how this hidden property of space-time may be the source of dark energy, the mysterious force that is tearing the universe apart and that has long puzzled physicists.

To begin unpacking all this, let's begin with black holes as described by Einstein's theory of gravity, general relativity. These behemoths form when a star exhausts its fuel and suffers a runaway collapse. All the star's mass gets sucked to a point of infinite density around which the vacuum of space-time forms a deep pit. From this, even light cannot escape. The boundary of this dark region, called the event horizon, can be quite large: if the sun could collapse to a black hole, the horizon would be about the size of a small city.

We know plenty about black holes; we even recently took photos of one specimen's exterior, which confirmed the shape of the boundary that is formed by the vacuum of space-time, as predicted by general relativity. But if we could look beyond the event horizon, I believe we would find that general relativity breaks down and quantum physics takes over. That is because our most cherished principles of physics are incompatible with the deep pit predicted by Einstein's theory.

The chain of reasoning for this started in 1973, when Jacob Bekenstein at Princeton University posed a question: what would happen if we threw a box of gas into a black hole? The gas has entropy, a measure of the disorder arising from the random positions of its atoms. So when the box disappears into the infinite-density centre of the black hole, he reasoned, this entropy seems to be lost. But the second law of thermodynamics, one of the fundamental principles of physics, says that entropy can't do this.

A piece of hot coal

Bekenstein suggested that the loss of entropy in the box of gas was compensated for by an increase in the overall entropy of the black hole. When the black hole swallows the box, its event horizon expands to occupy a larger area, and he argued that the entropy of the black hole is proportional to this area. But Bekenstein's black hole entropy was puzzling in several ways. First, in general relativity, a black hole is an empty vacuum, so what is the nature of the disorder? Second, the magnitude of this entropy was surprisingly large. Third, if a black hole has entropy then, like a piece of hot coal, it must also have a temperature and consequently it radiates particles. Yet according to general relativity, nothing can escape a black hole.

Stephen Hawking was among the physicists who tried to make sense of all this. In 1974, he made an amazing discovery: when we include the effects of quantum theory, a black hole does radiate. Hawking found that pairs of virtual particles pop into existence around the event horizon of a black hole. The stretching of space-time there, as described by general relativity, turns these into real particles. One falls into the back hole, but the other escapes in what's known as Hawking radiation.

Alas, the excitement of his discovery was short-lived. The next year, Hawking found a problem with his radiation process. Suppose we take two black holes with the same mass, but formed from stars made up of different kinds of atoms. The shape of space-time around the horizon would be the same in each case, and so the radiation emerging from this vacuum would also be the same. Since we can't use this radiation to differentiate between the stars, we have lost information to the black holes. This was a problem because physics works on the basis that information can't be destroyed.

Ever since, theorists like me have desperately tried to find a way for information to escape a black hole. There have been several proposed ›

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resolutions in recent years, but I believe string theory offers the most compelling way forward. Not only can it resolve Hawking's so-called black hole information paradox, but mulling it over more deeply has led me to some very intriguing ideas.

String theory is the idea that point-like elementary particles are, on closer inspection, extended objects made of one-dimensional strings (and "sheets" of varying dimensionalities called branes). It aims to unify quantum mechanics with gravity into a single theory of quantum gravity. In the mid-1990s, string theorists showed that a simplified general model of a black hole made of strings and branes would have the entropy predicted by Bekenstein. Soon after, in work done with Sumit Das, then at the Tata Institute of Fundamental Research, India, I used a similar approach to calculate that such objects would emit radiation at the rate found by Hawking. All this suggested we were on the right track to resolve the information paradox.

But we still had no idea about the form that particular black holes made from strings would take or how exactly they would store their entropy. By now I had spent almost a decade fighting with this problem, only to come up against the same wall each time. It was generally assumed that strings only had effects at the minuscule scale of the Planck length (1.6×10^{-33} centimetres), where both quantum theory and gravity become important. So how could strings possibly describe a vast black hole?

On the night of 29 May 1997, I was at a hospital keeping watch over my newborn daughter. To while away the hours, I tried to calculate what would happen if many, many strings and branes came together to make a black hole. The result was a shock. Its size was enormously magnified by the large number of strings and branes. Black holes made of stretchy strings were behaving very differently from black holes made of particles. When you squeeze strings, they don't compress into a singularity surrounded by an event horizon, as general relativity tells us, but they instead fluff up. The energy goes into stretching the strings out into tangles, called fuzzballs, that extend up to the black hole's event horizon.

Later on, with my colleague Oleg Lunin, then at The Ohio State University, we figured out the actual shapes of the simplest holes based on these ideas – work that was later extended to all kinds of black holes by Iosif Bena at Paris-Saclay University, France, and Nick Warner at the University of Southern California, among others. Each one of these stringy black holes can be organised in one of many different possible fuzzball shapes. This is similar to the way that in a box of gas there are many ways to arrange the gas molecules.

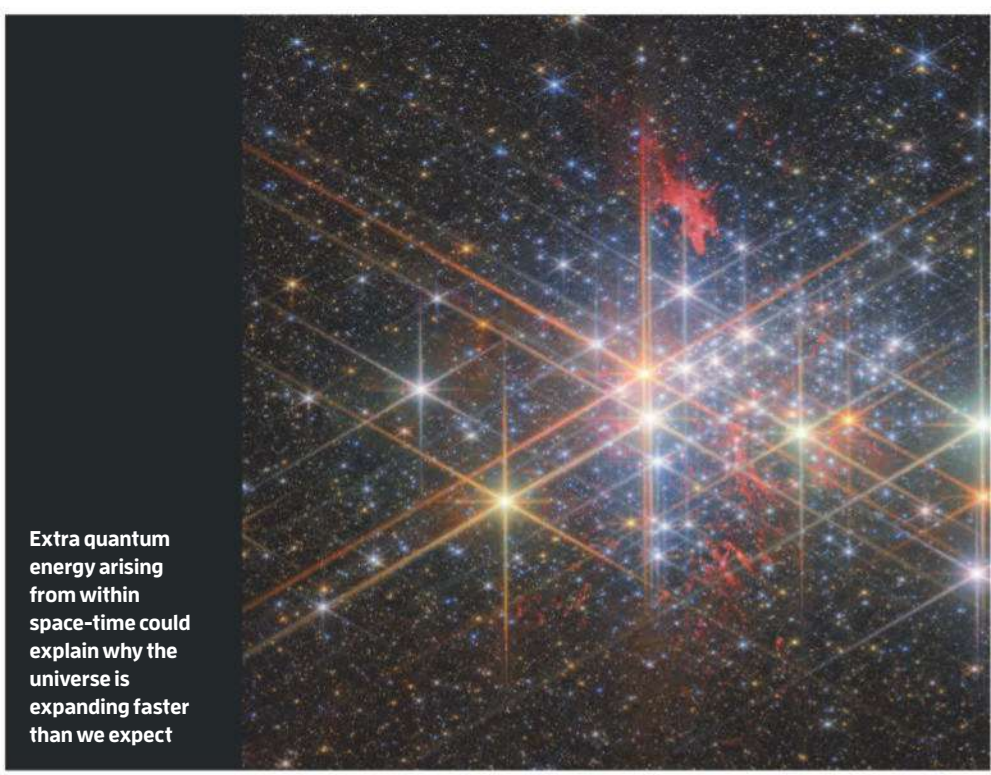
"There are virtual fuzzballs of all possible sizes, from zero to infinity"

This seemed to answer the puzzle of where a black hole's entropy was being stored: it lies within the multitudinous fuzzball shapes that comprise each black hole. More importantly, fuzzballs solved the information paradox by allowing information to leak out. In Hawking's paradox, random radiation comes out of the vacuum, but in the fuzzball picture, radiation is emitted from the stringy surface. This allows information to be encoded in the radiation so that it isn't destroyed.

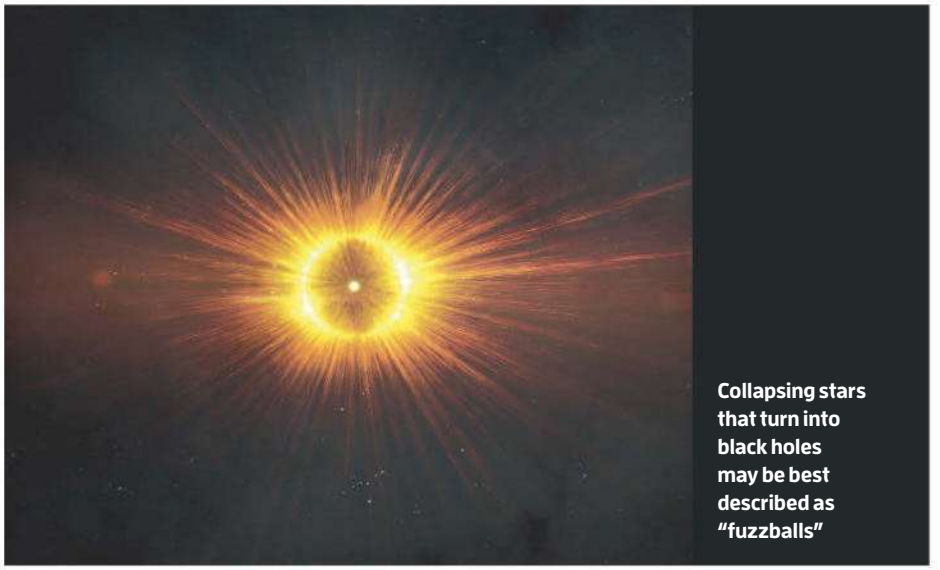
But there was still a critical, unresolved question: how does a collapsing star turn into a fuzzball? According to general relativity, which has stood up to every test thrown at it so far, a collapsing star should leave a vacuum shaped like a deep pit, rather than a fuzzball. So what causes Einstein's theory to fail – making way for a theory of quantum gravity?

The answer, coming from string theory, reveals a secret structure within the vacuum that changes our understanding of space-time in a fundamental way. What follows may sound like a just-so story, but the maths and physics underpinning this idea aren't fiction. It has been thoroughly examined and is feasible, theoretically speaking.

To understand how it works, we need to take a closer look at virtual particles. It is often said that these ephemeral counterparts of real particles pop in and out of existence, and indeed I have used that phrasing myself for convenience. But in truth that isn't a good way to think of them. Quantum physics paints all matter and energy as just fluctuations in the quantum fields that undergird all of reality. It is best to think of virtual particles just as very tiny disturbances in these fields. Like real particles, these virtual particles can be correlated with each other. For example, an electron and its antimatter partner the positron attract, orbiting each other as a "bound state". Likewise, virtual



Extra quantum energy arising from within space-time could explain why the universe is expanding faster than we expect



SHUTTERSTOCK/VADIM SADOVSKI

Collapsing stars that turn into black holes may be best described as "fuzzballs"

electrons tend to occur closer to virtual positrons, correlated through the strange phenomenon of quantum entanglement.

In this way, bound states of real particles leave an imprint in the structure of space-time: an intricate web of virtual correlations. Most of them operate at too small a scale to have any meaningful effect on black holes. But could there be other bound states whose virtual versions affect black holes and, perhaps, the entire cosmos?

I believe so. As we saw earlier, there are good reasons to think that black holes are fuzzballs made of strings. Strings are akin to elementary particles, which means that there are also virtual versions of these stringy bundles called virtual fuzzballs – which we could call virtual black holes. As far as we know, black holes can exist in any size from zero to infinity. So there are also virtual black holes of all possible sizes. What's more, there is a vast number of them due to the very large Bekenstein entropy. So, in the same way that virtual particles imprint a subtle web of correlations through the vacuum over very short distances, virtual fuzzballs do likewise, but across all possible distances, however large.

ESA/WEBB, NASA & CSA, M. ZAMANI (ESA/WEBB), M. G. GUARCELLO (INAF–OAPA) AND THE EWOCS TEAM

Shattered space

These correlations may be subtle but they have huge implications. To see them, let's now apply these ideas to the question I raised earlier: how exactly does a collapsing star form a black hole?

Well, during this process, space-time stretches. This means that the correlations created by virtual fuzzballs across the cosmos must alter the strength of their entanglement to reflect their new separations. This readjustment requires physical signals to be exchanged across the black hole region. But in the area created by a collapsing star, where space-time is being radically stretched, signals can't connect without travelling faster than light, which is forbidden by general relativity. As a result, quantum fluctuations in the pit-shaped region are unable to develop the correlations required to form a stable, low-energy vacuum. Instead, these fluctuations effectively tie space-time in knots until it shatters. The result isn't a stretched vacuum, but a stringy fuzzball mess.

In short, general relativity fails when space-time stretches too fast. Similar reasoning suggests that Einstein's theory should also fail across the largest spans of the expanding universe – which is like a collapsing star in reverse. It takes too long for signals to be exchanged between two points in the vacuum separated by billions of light years. So, once again, virtual fuzzballs cannot imprint space-time with the correct correlations across these distances. This means that the cosmos isn't a perfect vacuum on these scales, but carries extra quantum energy. When I ran the maths in a paper published in December, I found that the relevant scales are exactly those at which we observe the effects of dark energy.

Astronomers first postulated dark energy in the late 1990s when they found that distant exploding stars called supernovae were consistently fainter than expected. They figured out that these supernovae must be much further away from us because the intervening space was stretching. In other words, there was a mysterious force pushing the universe apart ever faster at its furthest reaches. To account for this, cosmologists stuck dark energy into the equations of general relativity, but with little idea about its origin. But now it appears that the extra quantum energy generated by virtual fuzzballs could be driving this expansion.

Recent observations back up this idea further. The Hubble tension is a discrepancy between how fast the universe seems to be expanding and how fast we expect it to do so based on our best model of cosmology. The mismatch can be resolved by postulating a sudden sharp burst of additional dark energy – called early dark energy – billions of years ago when the universe changed from mostly radiation to mostly dust. Virtual fuzzballs suggest a natural explanation for early dark energy: the equations of cosmic evolution tell us that a dust universe expands faster than a radiation one, and the faster the universe expands, the harder it is to form correlations between virtual fuzzballs. Once again, this yields an extra burst of quantum energy, this time at the transition from radiation to dust, which in this case is the right size to resolve the Hubble tension.

Telescopes like the Dark Energy Spectroscopic Instrument are beginning to precisely measure dark energy and how it might change over the course of cosmic history. My hope is that soon we may be able to match these precise observations with the behaviour of dark energy that emanates from the secret structure of space-time. ▮

Samir Mathur is a theoretical physicist who specialises in string theory and black holes at The Ohio State University

DRESS TO IMPRESS

Our ancestors invented clothing to keep warm, so how did it become a thing of beauty, style and symbolism? **Alison George** investigates

MARTIN PARR/MAGNUM PHOTOS

VENUS figurines are most famous for their sexual features. These often-voluptuous carvings of female forms, made between around 30,000 and 20,000 years ago, have been interpreted as ritual fertility figures, mother goddesses and self-portraits. One thing they are generally not seen as is fashion plates. Yet some of them provide tantalising glimpses of what the well-dressed Stone Age woman was wearing. One, from Kostenki in Russia, sports a wrap-style robe with straps. Others have string skirts. And the famous Venus of Willendorf (pictured, page 37) wears just a woven hat – but a very fine one.

These statuettes are a far cry from our popular conception of prehistoric humans draped in animal furs. The lavish detail with which their garments are depicted indicates the importance of clothing to societies tens of thousands of years ago, according to archaeologist Olga Soffer, professor emerita at the University of Illinois Urbana-Champaign. Something that began as a necessity, to keep people warm, had by then morphed into a canvas for aesthetic expression and meaning. Now, the story of how that happened has taken a twist, thanks to some new discoveries.

Clothing is perishable, and the oldest remains are only around 10,000 years old. But, as the Venus figurines illustrate, we can follow trends back in time in other ways. These archaeological clues reveal the origins of both simple capes and complex tailoring to be remarkably ancient. Most surprising, though, is research into the technology most strongly associated with clothing, needles. This is now revealing how our ancestors transformed clothing from a utility into a social necessity and means of self-expression.

"Wearing clothes and not appearing naked in public may seem perfectly natural for us, but this habit is really very unusual," says Ian Gilligan at the University of Sydney, Australia. "There are no other animal species that use clothes." Admittedly, there are rare examples of non-human animals adorning their bodies with items and passing on this trend to their peers – orcas wearing salmon hats, for instance, and chimps choosing to put a blade of grass in their ear – but humans take getting dressed to a completely different level.

To understand how this came about, we need to go back around 2 million years, which is when our ancestors are thought to have lost their fur. This, combined with an enhanced ability to sweat, would have helped them survive in the hot, dry climate that prevailed in parts of Africa at that time. However, the lack of body fur became a distinct disadvantage later when the climate got colder, and also when these hominins moved to cooler regions. Being inventive species, though, our ancient ancestors devised ways to overcome this

Today, clothes are a means of self-expression and group identity – and we wouldn't go out without them

thermal obstacle. "We don't have clothing from that time," says Gilligan. "But we do have indirect evidence in a number of areas."

The first hints that hominins were covering up come from flat stone tools called hide scrapers, which begin to appear around 500,000 years ago. These were used to clean the inside of hides, which is an essential step in the production of fur clothing. This development corresponds with a key turning point in Earth's climate. Not only did average temperatures become cooler, but there were extreme temperature swings over timescales for which it wouldn't be possible to evolve the traits needed to cope, such as regrowing fur. "It's quite incredible to see this coincidence between the first evidence of use-wear on stone tools for working skin, and the fact that at 500,000 to 400,000 years ago you come into this period which is both colder and sometimes experiencing very rapid climate change," says Francesco d'Errico at the University of Bordeaux, France.

But our ancestors' commitment to clothing was not yet complete. Hide scrapers are more common at sites occupied during colder phases, compared with warmer ones. "This indicates that people wore clothes to keep warm when necessary but went naked when the weather improved," says Gilligan. In other words, clothing was utilitarian and only used on an ad hoc basis.

More clues about early clothing come from distinctive cut marks on bones that signify an animal was skinned for its fur. For instance, analysis of bones at Contrebandiers cave in Morocco suggests that leather-making occurred there at least 90,000 years ago. Meanwhile, footprints of a child, probably Neanderthal, show that they were wearing shoes around 120,000 years ago in what is now Greece. Then there are lice. Genetic studies ›

"AT FIRST, CLOTHES WERE UTILITARIAN AND ONLY WORN ON AN AD HOC BASIS"

indicate that clothing lice evolved from head lice by at least 83,000 years ago and as far back as 170,000 years ago. This suggests that some human populations were wearing clothes well before then. Lice need to feed on human blood at least every three or four days, so this speciation "marks the beginning of wearing clothes on a fairly regular basis", says Gilligan.

The first clothes were probably loose garments such as capes and poncho-style cloaks – easy to make, but not so warm in very cold conditions. However, thanks to rare discoveries from the past two decades, we now know that this began to change around 75,000 years ago when people in southern Africa invented a new type of tool called an awl. These piercing implements fashioned from bone would have made it possible to make seams, leading to tighter-fitting clothing. The oldest known awls come from Blombos cave in South Africa, and an analysis of the wear marks indicate that they were used to make holes in soft material such as well-prepared hide. Awls turn up in Carpenter's Gap in Australia around 47,000 years ago and in Europe from around 45,000 years ago, after which they became an increasingly common feature in the toolkits of the people living in these regions.

Inventing underwear

Further evidence that clothes were becoming more fitted was found in 2023. Analysis of a 39,000-year-old bone fragment discovered in Spain suggested it was a punch board used for making holes to create seams in leather. A strange pattern of notches in the bone appear to have been formed when a chisel-like stone tool called a burin was knocked through a hide – a method still used today by cobblers and in traditional societies. Thread could then be pushed through holes to make a tight seam.

These tools and techniques are significant, because they allowed people to create fitted clothing and don multiple layers of garments –it was the beginning, if you like, of underwear. And this warmer clothing enabled people to expand into places they were not physiologically suited to. It may even help explain why *Homo sapiens* thrived after migrating to Europe around 45,000 years ago during the last glacial period, whereas Neanderthals died out around 40,000 years ago. Mark Collard at Simon Fraser University, Canada, and his colleagues found that sites occupied by Neanderthals contained fewer bones of animals with pelts that make good clothing, such as bears, bison and deer.

"NEEDLES MARK THE POINT WHEN CLOTHING BECAME A FORM OF SELF-EXPRESSION"

The beads in this 34,000-year-old grave were once attached to clothes

SCIENCE HISTORY IMAGES/ALAMY

In addition, unlike the *H. sapiens* sites, there were no traces of animals with a mix of long and short hairs – like weasels, wolverines and dogs – whose super-warm pelts would have made an ideal trim for hoods and sleeves. Neanderthal clothing has been much debated, with some researchers arguing that they wore nothing. Other findings suggest that they used only cape-like clothing, which may not have been enough when temperatures plummeted.

So far, so functional. What changed to turn utilitarian clothing into fashion? It can't have been a cognitive leap because humans clearly had an urge to adorn themselves long before this. Pierced shells found in Africa indicate that people were making necklaces at least 142,000 years ago. And there is plenty more evidence that, as well as jewellery, we have a long tradition of altering our bodies with tattoos and scars, and painting them with the red pigment ochre. Instead, the innovation appears to have been a technological one. And this is where needles come in.

Archaeologists once considered the invention of needles to represent the dawn of clothing, but we now know this happened long after people began to make tailored garments, says d'Errico. Eyed needles were created with a simple amendment to the awl – the addition of a hole in which to insert thread. Made from animal bones, ivory or antlers, and requiring a big investment in time and skill to manufacture, needles first appear in the archaeological record around 40,000 years ago, in Denisova cave in Siberia, but were rare until the colder temperatures of the last glacial maximum 23,000 to 19,000 years ago. Eyed needles seem to have been invented independently in China around 30,000 years ago. The finest of all, however, were made by the first people to reach North America, and they must have been key to producing the tailored clothing needed to survive in the frigid north of the continent.

But now a new study by Gilligan, d'Errico and others, investigating why needles were invented, highlights how an overlooked aspect of this innovation transformed the way people dressed. The researchers argue that needles didn't just allow our ancestors to make more functional garments, they could also create more beautiful ones through embroidery or the attachment of decorative items such as beads, shells and feathers. In other words, needles mark the point when clothing became a form of self-expression.

Dramatic evidence for the importance of decorated garments, and the lengths people went to create them, comes from a remarkable

IMAGNO/GETTY IMAGES; FINE ART IMAGES/HERITAGE IMAGES/GETTY IMAGES; FRANCESCO D'ERRICO

The Venus of Willendorf, Stone Age shell beads and bone tools called awls all testify to the early origins of fashion

burial of a man and two children 34,000 years ago at Sungir near Moscow (pictured, left). Their bodies are covered in huge numbers of beads that must have once been attached to clothing. "You've got thousands of mammoth ivory beads that were around the skeletons, and they're in such a pattern that clearly show they were sewn onto separate sleeves and shirts and trousers," says Gilligan.

The ability to decorate clothing through the development of fine needles may not sound like much, but Gilligan argues it marks a quantum leap in human cultural evolution. "What eyed needles confirm is this transition in the function of clothing from a thermal necessity to a social necessity," he says. "People have transferred the important social and psychological functions of body adornment from the naked skin surface – with body painting and scarification, and tattooing – onto the surface of clothing." As today, what someone wore carried messages about their identity. "Clothing moves from being just functional to taking on these other symbolic aspects... as a way of broadcasting who you are," says April Nowell at the University of Victoria, Canada. This means that when strangers met, their clothing would advertise information about them such as which ethnic group they belonged to, their social status and even which language they spoke.

Gilligan believes clothing became a social necessity in mid-latitude Eurasia during a period of heightened cold between 40,000 and 22,000 years ago. If so, then the materials worn weren't limited to fur and leather. By this stage, textiles made out of wool and woven plant material had been invented too. Their origins are far from clear. But we do know that Neanderthals were capable of making three-ply string 50,000 years ago. And imprints of clothing left on ceramics show that *H. sapiens* living at Moravia in the Czech Republic were wearing woven clothing 27,000 years ago.

> "30,000-YEAR-OLD SPUN FLAX WAS DYED BLACK, GREY, TURQUOISE AND PINK"

Then, of course, there are the Venus figurines. Although some, including the Venus of Willendorf, are undoubtedly clothed in textiles, others wear fur. These include carved ivory figurines found at the Siberian site of Mal'ta. "They're wearing head-to-toe clothing," says Nowell, complete with hoods. Although they may not have dressed in the latest fabrics, they have another story to tell. Analysis of their surface has revealed that they were originally covered in bright pigments – red, blue and green – hinting that clothing from this time was vividly coloured. More evidence to back up this idea comes from the discovery that 30,000-year-old spun flax found in Georgia was dyed black, grey, turquoise and pink. "This has totally changed how I imagined that world," says Nowell.

Mind-boggling skills

That's not the only way this research challenges our preconceptions about Stone Age people. "The study of clothing can help us understand things like planning, forethought and intergenerational knowledge transfer," says Nowell. In today's industrialised societies, with a wealth of garments readily available in the shops, it is easy to forget the immense amount of skill that goes into making clothes, especially when you have to source and create the raw material – animal hides, wool or plant fibres – yourself. "It's mind-boggling, when you think about it, all the different kinds of technologies and knowledge of materials," says Nowell. "And then how do you teach that over generations – the dyeing, the aesthetics of it? Those are things that are learned from one generation to another. It's a massive, cumulative knowledge."

Some researchers even think that the skills our ancestors honed to make clothing could have sparked other technological innovations. For instance, in a study published in 2024, researchers suggest clothing production inspired the invention of the wheel. They believe that 12,000-year-old stone objects found in Israel were spindle whorls, devices still used today to spin thread. This would make them an early example of rotation technology, incorporating ideas essential for creating the first wheels, which are thought to have emerged some 6000 years later.

But it was the invention of the needle that transformed clothing into what it is today. With clothes being worn on a regular basis in certain societies, and not just for utilitarian reasons, notions of modesty around the naked body arose. And the rest, as they say, is history – not just our dedication to fashion but also the fact that most of us wouldn't be seen dead in public without clothes, even when we don't need them to keep warm. ▮

Alison George is a features editor at *New Scientist*

"By bending rules and giving themselves excuses, people don't see that they're being racist"

Despite clear scientific evidence on the prevalence of racism in society, we often ignore – or are unaware of – how it influences our behaviour, says psychologist **Keon West**. He tells Amarachi Orie how we can overcome deception to tackle racism

KEON WEST could reel off anecdotes about the everyday racism he experiences – but he won't. Personal accounts rarely convince anyone, he says, and, all too often, they are dismissed or put down to some other, less offensive, cause. Instead of the feelings that racist behaviour and accusations of racism provoke, he prefers to focus on facts.

A social psychologist at Goldsmiths, University of London, West has consolidated hundreds of rigorous empirical studies on racism conducted over decades in his new book, *The Science of Racism*. By exploring how experiments can detect racism and measure its impact across societies, he builds a scientifically accurate picture of what contemporary racism is and the complexities that surround it.

While it is clear that society's attempts to combat racism remain inadequate, there is plenty that can be done about it. The same studies that prove the existence of racism can also help us unpack the psychological gymnastics that nearly everyone performs to conceal their racist behaviours from themself. The idea is that, by becoming aware of these personal biases, many racist behaviours can gradually be dissolved.

In this interview, West sheds light on ideas like systemic racism and lays out the science-backed methods of spotting racism in its various guises. Doing so, he hopes, will steer public discourse away from debating whether racism exists to confronting it head on.

Amarachi Orie: What is racism?
Keon West: There are two definitions that I think are useful. There's one that's useful for running the scientific experiments: racism is any detectable difference in treatment between two otherwise identical people that can be attributed to race uniquely.

But there's another definition that I think is important: racism is prejudice plus power – because what we're ignoring is a huge system of advantages that are built in, that are systemic, that happen even if no one is treating anyone any differently.

How do scientists accurately test for racism?
Pick something where you think people could be racist.

Hiring.
All we have to do is create 100 copies of a CV or résumé with, say, Tanisha Brown's name on it and then another 100 with Emily Cooper's name on it, but they're the same CV. Then we send them out to people and see how people respond to these CVs.

That test has been done hundreds of times. It's been done in the UK, the US, France and Australia. It's been done so many times that researchers can then smush all of these together and create meta-analyses of these studies, and the one thing we know for a fact is that when Emily Cooper and Tanisha Brown are equally qualified, they do not get hired at the same rates. At every stage, Emily Cooper is promoted and Tanisha Brown is disadvantaged. Every single time. We know the only explanation is the race. ›

BECKI GILL

"I have seen people stunned by the outcomes of implicit bias tests"

How are people able to be racist, and hide that from others, in a way that can show up in a scientific study?

There's a great study where researchers send in people to interview for jobs in the US. They send in a Black person, a white person and a Latino person who are equally qualified, have the same experience, have been trained to behave uniformly, are dressed similarly and have been matched on physical attractiveness, verbal skills and interaction styles. In that study, they found that those hiring will give different reasons for not giving someone the job – effectively telling lies depending on who they are talking to. They'll say to the Black person: "I'm sending you away because we happen to be closed today" or "Oh, I'll have to call your references. We do that with everyone." But then they don't do that when a white person comes in. The employers don't call to check the white person's references, but just offer him the job anyway. You can see that happen in a study.

Of course, in real life, you only have your own experiences, you're only dealing with one candidate at a time (yourself). You don't have these Black, white and Latino copies, so it's hard to know when certain behaviours occur because of race.

What are the different types of racism according to psychology?

There are so many different kinds of racism. I like to remind people that there's still quite a lot of open, explicit racism everywhere in the world. I think we've got really quite attached to unconscious bias. This is bias that you are unwilling or unable to accurately acknowledge. For example, you may believe that someone is being hostile and you think you're perceiving the threat from their behaviour or their hand gestures, but it's actually just the skin. That's what's triggering your threat response.

KATHARINE GRAHAM/ASSOCIATED PRESS/ALAMY

But unconscious bias isn't the most prevalent kind or the most important kind of racism. There is the insidious racism of paternalistically lowered expectations, the kind of racism where people will explain basic words to you. There is aversive racism in which people are very careful not to be racist until they have an excuse. They don't have to say: "I just don't like Black people." They'll justify it, saying: "Well, I heard this rumour, so that's why I don't like this person."

How can someone be racist without realising that they are being racist?

Aside from unconscious biases, the other way is that people do things like explicitly say "I'd rather date white people", but they don't call it racist. What they do is construct a series of excuses for why they're behaving in a racially discriminatory way, but then categorise their behaviour as not being racist.

There's a whole bunch of research on this, and some research on stuff I did myself called definitional boundaries of discrimination, which is how we draw the line around what we call actually racist and what we call acceptable.

Police in the UK and the US can stop and search people based on suspicions alone

BRADLEY STEARN/ALAMY

Boardrooms were exclusively white in the past – and still lack diversity today

What it does is it allows us to be flexible with our definitions. "I'm not going to hire someone like that for this post. But I have a good reason. Five years ago, I hired a Black person and they didn't do very well, so I'm not going to do that again. I'm not racist. I'm just learning from my mistakes." "I don't pick up Black people in my taxi. Everyone knows they don't tip. I'm not racist. If they would just tip, I'd do that quite differently." People do this all the time. By bending these rules and giving themselves excuses, they don't see that they're being racist. They get to continue doing racist stuff, but never acknowledge it as racist.

If someone is using psychological tricks to hide their racism from themself, how can they become aware of this?

You become aware of things through external feedback. I would encourage everyone to do an implicit association test. This is where you have to quickly combine certain categories – such as "good" and "bad" with "Black people" and "white people" – to indicate your level of implicit bias, which is bias that you are unable or unwilling to report. I have seen people stunned by their outcomes, and sometimes quite hurt by them. But they're insightful.

What are the effective ways of tackling racism?

If you want to change your own personal racism, if you're like, "I hate Muslims and I want to do something about that", I would say you need to spend time in the local mosque. You need to go and see Muslims and talk to Muslims. You need to buy books written by Muslims. You need to watch television programmes made by Muslims. You need to immerse yourself in their lives and their emotions and what they care about.

But many of the changes required are in the structure of society. There are many things that stop people of colour from having power. I don't like "stop and search" – which gives police in the UK the power to search someone based on suspicions alone – but it could be made better if you shift the power so the police officers who stop and search you and find nothing now face serious repercussions. You put more power in the hands of the people who are victimised and less in the people doing the victimising – that will change the dynamic.

What does the definition that racism is prejudice plus power tell us about the notion of "reverse racism". For example, do you believe Black people can be racist to white people?

Black people can dislike white people very strongly, but I don't call it racism and I'm not alone in that. Psychologist Beverly Daniel Tatum explained it very well to me. If all the Black people in the UK collectively decided that we hated white people, that our collective goal was the extermination of white life in the UK, this would not bother [white people]. They wouldn't like it. They'd be uncomfortable. But the prime minister is still white, most police officers are still white, most people who work in banks are still white, most CEOs are still white, most judges are still white. Regardless of our levels of anti-white hatred, there's little we could do.

But we have seen what happens when white people get up en masse and decide that their goal is the extermination of another race of people. They are horrifyingly successful at that, whether we're talking about the Native Americans in the US or Jewish people in Germany. If they get up en masse tomorrow and decide their goal is the extermination of all Black people in the UK, we are probably going to die – and that disparity is important.

Does improving individual racism improve systemic racism?

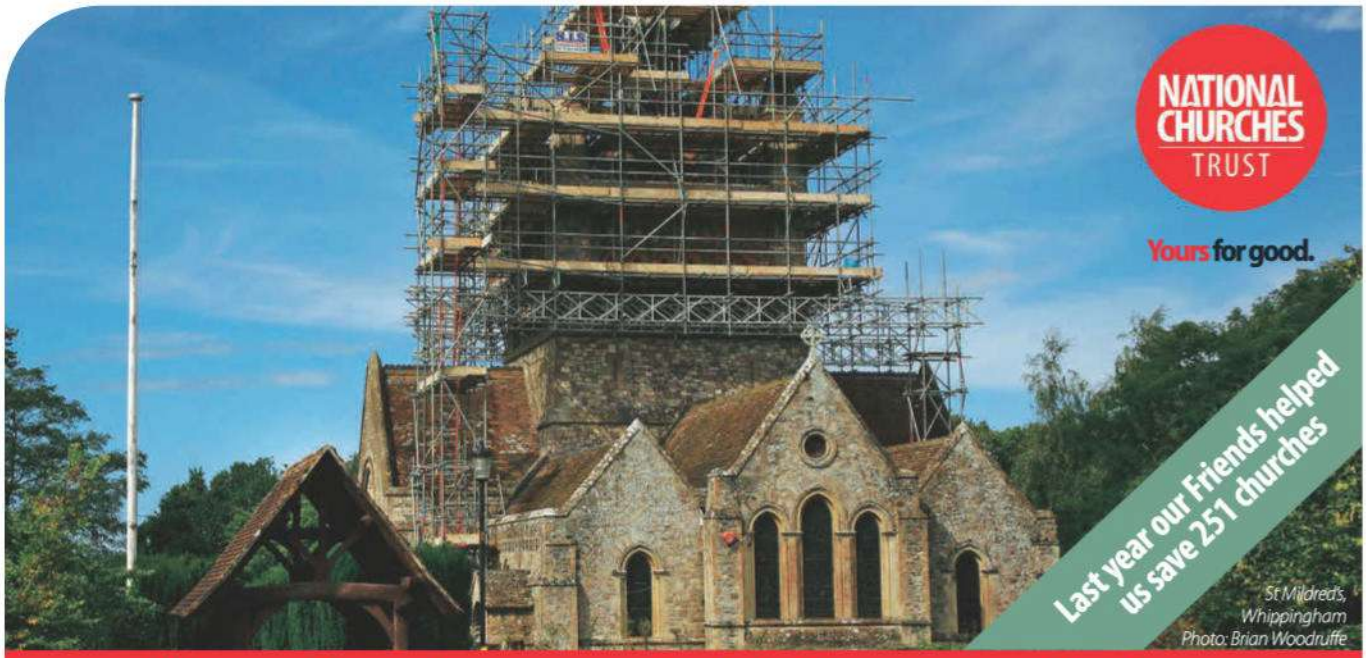
Systemic racism is anything wherein there is a system that continues to function to produce racist outcomes, even if no one in the system is trying to be racist or no one is being racist. On some level, systemic racism doesn't need racists to function, but it's worth noting that racists keep it going. Individuals are part of systems.

You're not going to get a change in a law, abolish slavery or end apartheid without changing individual people's minds. But the unfortunate truth is that people can like you a lot, but not be any nicer to you.

There's a lot of good experimentation out there that shows that if you make people like each other more, this change in how much they like each other will be genuine, but they may not behave differently. They won't hire you more. They won't assign more resources your way. They won't be better to you in ways that count.

Changing individual racism is important, but if you stop there, that's insufficient. The truth is that often a fight for power is part of it. If you really want change, think about power as well. ▮

Amarachi Orie is a freelance journalist based in London, UK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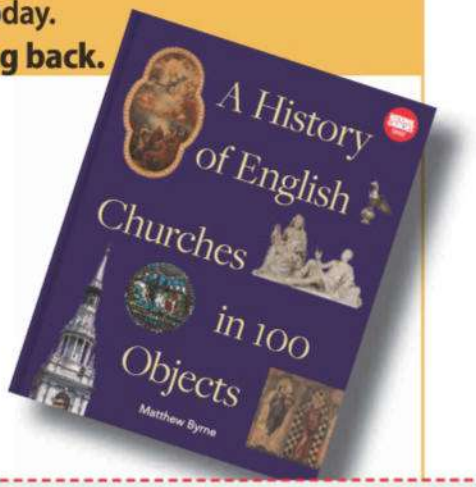

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Stargazing at home

A galaxy far, far away

We will never get an image of the Milky Way from above, but **Leah Crane** has a solution: look out for another spiral galaxy, M81

Leah Crane is a features editor at *New Scientist* based in Chicago. You can reach her at launchpad@newscientist.com

What you need

A small telescope or pair of binoculars

Stargazing at home appears monthly

Next week

Mathematics of life

THERE is something about seeing our home from a distance that is special – whether it's spotting your neighbourhood from an aeroplane or looking at pictures of Earth taken from space, it lends a sense of perspective. Astronauts call this the overview effect: a feeling of awe and connection to the communities and world around us, and the beauty of our little green planet. It has always seemed a bit sad to me that we couldn't get an even broader perspective, a picture of our whole solar system or galaxy from afar, to help put into perspective how tiny our world is, how special.

But even though we will never get an image of the Milky Way galaxy from above – it is simply too big for us to send a spacecraft far enough – this month is a perfect time to spot the next best thing. In the northern hemisphere, if you have a small telescope or even a decent pair of binoculars, you can look out for another galaxy similar to our own, called M81 or Bode's galaxy (pictured).

This galaxy is about 12 million light years away, so it isn't even in the top 100 closest galaxies to our own. But at nearly 100,000 light years across, its size and brightness make it one of the best to observe. It is only slightly smaller than the Milky Way, and both are spiral galaxies, so looking at Bode's galaxy may be the easiest way to see what our own galaxy would look like from afar.

There are some differences between the two. The Milky Way is a barred spiral galaxy, meaning its arms protrude from a huge bar-shaped block of stars at its centre, while Bode's galaxy is a "grand design" spiral, so it has more defined arms and no bar. But what it lacks in a bar, it makes up for in lucky positioning: it is almost perfectly face-on to Earth, so if you have a strong enough telescope (one about 8 inches or bigger), you might be able to make out the individual arms swooping out from its bright, dense centre.

ALFJACOB NILSEN/ALAMY

The best time to spot Bode's galaxy is around midnight, when it is at its highest in the sky. You can locate it using Ursa Major, also known as the Big Dipper or Plough. If you can find Dubhe, the star at the very top of the Dipper's dipper, the galaxy is about 10 degrees north-west from there. Picturing it being along a line drawn from Dubhe to the star opposite it on the dipper, Phecda, may help.

If you can, imagine that Bode's galaxy is our own Milky Way. The solar system is located on a small spiral arm, about halfway between the galaxy's centre and its edge. Every other tiny point of light in the galaxy is another star, probably with at least one other planet, and there are hundreds of billions of them in our galaxy and Bode's. That is just about one solar system for every human who has ever lived. Even if there is other life out there in the universe, I think that makes Earth and the little lives we lead here pretty special. ∎

These articles are posted each week at newscientist.com/maker

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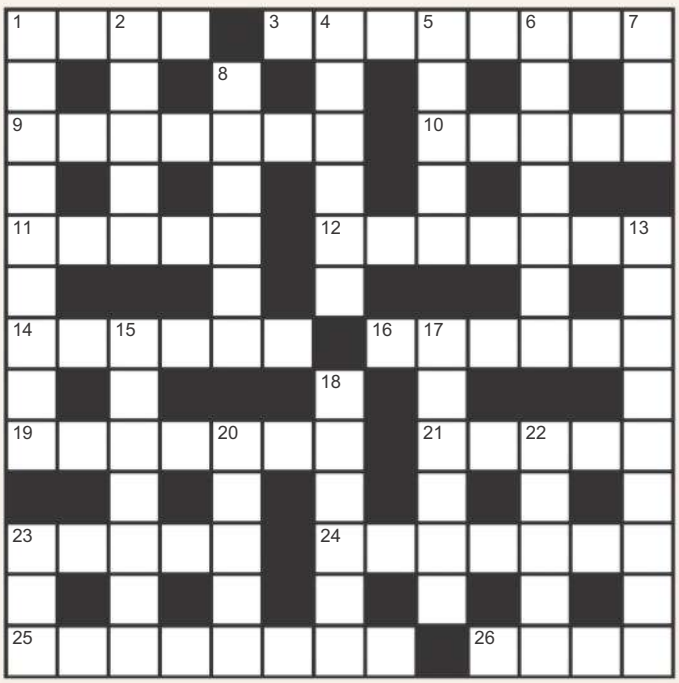
Cryptic crossword #154 *Set by Trurl*



Scribble zone

Answers and the next quick crossword next week

ACROSS

1 Ditched fence – LOL! (2-2)
3 Gathering with Latvian leader in derelict embassy (8)
9 Mostly hopeful for pain relief (7)
10 The lens, uncovered, discloses great beauty (5)
11 Thorium spirit generating rhythmic noise (5)
12 Conflict resulting from rejection of undercooked food (7)
14 Departure, say, on steamship (6)
16 Vinegary monk dismissing head of seminary (6)
19 Moon fairy (7)
21 Badger and bother, noisily (5)
23 Speculative concoctions produced if iodine, carbon and sulphur subjected to rotation (3-2)
24 One who sees a lot when given a hand (7)
25 Having pancreatic disorder, I cited a book's heading incorrectly (8)
26 Lead player in arts representation (4)

DOWN

1 Father let loose, to be honest (9)
2 Booster going above and beyond? (5)
4 Directions given under system of units – they help keep people together (6)
5 Without whisky or heroin, if it's like alcohol (5)
6 Big Ben, say, heard running ahead of time in UK city (7)
7 Longing for foreign capital (3)
8 First Roman cooker? (6)
13 Automated flight (9)
15 Put drop of spirit in optic component to produce drink (7)
17 Ring group of friends (6)
18 High-achieving personality spoken of in Asian city (6)
20 Unworldly one seen in part of church (5)
22 Surprising development in dance (5)
23 Down with the winter blues! (3)

Our crosswords are now solvable online
newscientist.com/crosswords

Quick quiz #287
set by Corryn Wetzel

1 Who is the youngest person to ever receive a Nobel prize?

2 Which planet in the solar system has the shortest day?

3 What is the name of the scale that measures how resistant a mineral is to scratching?

4 Which element is named after the Greek words for "acid former"?

5 In what year was the International Space Station launched?

Answers on page 47

BrainTwister
set by Mary Ellis
#58 Fulfilling fractions

Arrange the numbers 1, 2, 3, 4, 5 and 6 into three fractions. Choose two of the fractions and multiply them together, then add the third fraction. What is the largest number you can make?

Using the fractions 0/7, 3/9, 2/5, 8/4 and 6/1, and the operations +, –, × and ÷ once each (and brackets as needed), can you make a value of 7?

It is possible to make a number as big as 1512 using the digits 0-9 and those four operations once each. Fit the digits 0-9 into this equation, replacing the dots, to make it true:

$$(\frac{\bullet}{\bullet} \times \frac{\bullet}{\bullet}) \div (\frac{\bullet}{\bullet} - \frac{\bullet}{\bullet}) + \frac{\bullet}{\bullet} = 1512$$

Solution next week

Life on Mars

Should we be thinking about genetic modifications for the humans that we send to colonise Mars?

Pat French
Longdon Upon Tern, Shropshire, UK
No. We cannot know what the optimum characteristics are for life on Mars. We may think that we understand the various Martian environments, but it is certain that our knowledge is incomplete. Also, even unaltered, our species quickly discovers ways to do things that haven't been predicted – for example, the bouncing method of walking on the moon.

Even if it were to be attempted, it would take generations to establish those genetic changes within a group (to create a specialised genotype).

Supposing that the project started out with volunteers, it would have to impose participation on following generations that had the required genes and reject those children who didn't. In most societies, this is totally unacceptable.

Over the duration of such an extended project – prior to the interplanetary journey – there would be huge changes in our society, technologies, politics and global finance. The effort would be under constant threat.

> **"Any pioneer population that reached Mars might phase out those genes that actively hindered survival"**

Alternatively, any pioneer population that reached Mars and became established might quite naturally develop useful genes and phase out those that actively hindered survival. Even then, it would take many generations. Further, it would require a society that allowed those not suited to Martian life to die out. Modern humanity supports vulnerable people rather than abandoning them.

It would be much quicker and much more productive to send pioneering machines to Mars well before humans make the attempt. Such machines and robots can be "evolved" many times in a single human lifetime. By evolving those machines here or on the planet, humans can learn so much more regarding what we might need to survive on Mars as normal human beings.

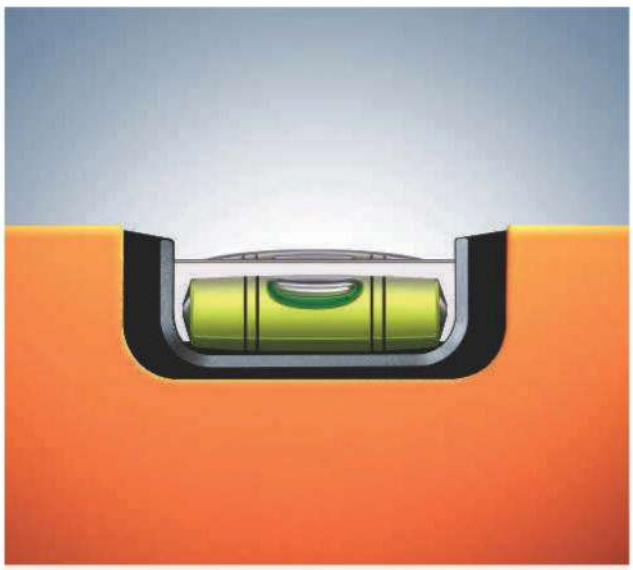
Mike Follows
Sutton Coldfield, West Midlands, UK
This question has been explored by Kim Stanley Robinson in his *Mars* trilogy of novels. His first Mars colonisers were called the First Hundred, and they quickly divided into two factions: the Greens were in favour of genetic modification and the Reds were against it. This became a source of tension.

Given that ethnocentrism already exists on Earth based on smaller differences – including ethnicity, religion and culture – engineering significant genetic differences might introduce another source of discrimination that could lead to conflict on Mars and between Martians and the people back on Earth. Moreover, each desired attribute would require modifying many genes. The modified genes could interact in unexpected ways, leading to unforeseen health problems or unintended side effects. It might even be the first step towards speciation, though this would require prolonged isolation of the Martian population.

Ionising radiation is one of the most significant risks for humans travelling in space or living on Mars, as the planet lacks Earth's magnetic field (which deflects cosmic and solar radiation) and a thick atmosphere to absorb it. Some geneticists, such as George Church, believe that genes can be edited to make humans more resistant to ionisation. Another option may involve incorporating the DNA of other, radiation-hardened species like microscopic tardigrades. Of course, one conventional alternative would be to have colonisers live in subsurface settlements.

Instead of expensive and heavy shielding, astronauts travelling through interstellar space could breathe a cocktail of therapeutic gases to protect against radiation exposure by, for example, neutralising the harmful free radicals it produces. Some professional divers breathe gas mixtures to avoid decompression sickness or nitrogen narcosis. Maybe future astronauts will use "liquid breathing", as depicted in the film *The Abyss*.

The gravitational field strength on the surface of Mars is 38 per cent that of Earth, which could lead to muscle atrophy and a loss of bone density (osteoporosis). Adaptation of the heart and blood vessels would also be required. While genetic modification is one option, technical solutions are also available, such as generating artificial gravity through the spinning of spacecraft (based on the O'Neill cylinders concept), as depicted by the Endurance spacecraft in the film *Interstellar*. These spinning cylinders could either be placed in orbit around Mars or positioned on tracks on the surface in the form of spinning cones – to take account of the planet's gravitational pull.



MALERAPASO/GETTY IMAGES

If this bubble, or spirit, level lies flat, what does that actually mean, relative to Earth?

This week's new questions

Flat out **When a bubble, or spirit, level is level, what does that mean relative to Earth?** ***John Snape****, Barnham Broom, Norfolk, UK*

Spinning around **Does life require Earth's rate of rotation to lie in a certain range? What are those limits and what changes to life's existence would there be as those limits were approached?** ***John Grant****, Shelly Beach, Queensland, Australia*

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Tom Gauld
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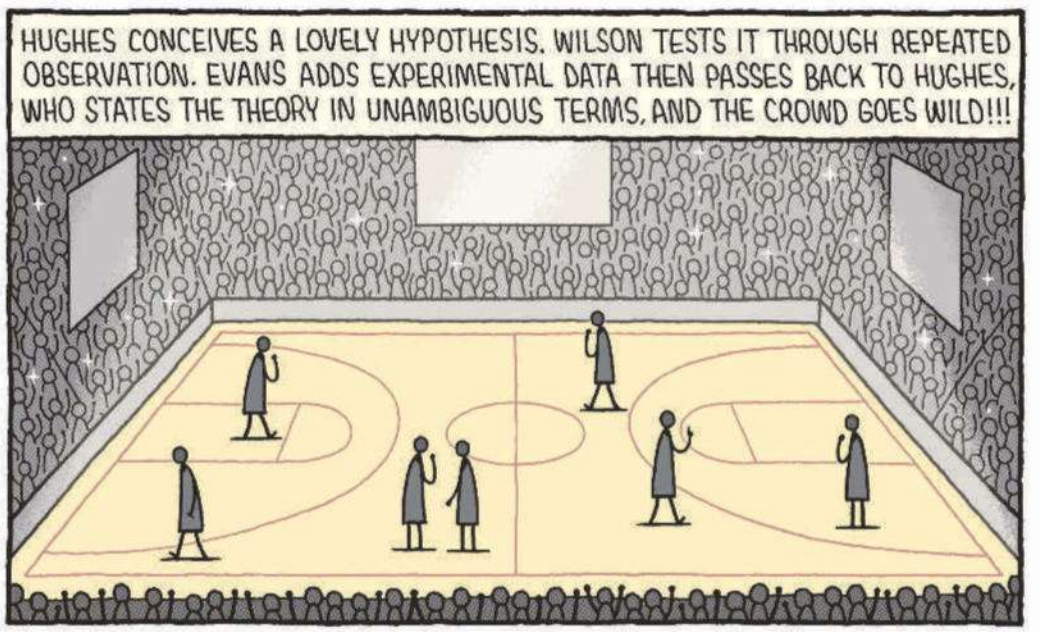
HUGHES CONCEIVES A LOVELY HYPOTHESIS. WILSON TESTS IT THROUGH REPEATED OBSERVATION. EVANS ADDS EXPERIMENTAL DATA THEN PASSES BACK TO HUGHES, WHO STATES THE THEORY IN UNAMBIGUOUS TERMS, AND THE CROWD GOES WILD!!!

Simon Dales
Oxford, UK
The best "human" for Mars might well be a Dalek. If we are to live entirely in a life-support system, then we need to adapt to that. Their bodies are much smaller and lighter, so fit better into spacecraft. And they have a lower metabolic rate, so provisions last longer.

These Daleks would need a redesigned robot exoskeleton because the traditional sink-plungers on their arms don't give good dexterity. Otherwise they would need to bring along some regular humans for fiddly jobs.

Forest life

Why don't trees rot in the ground, while wooden structures do if they aren't built properly?

Chris Daniel
Colwyn Bay, Conwy, UK
Trees are living organisms that can respond actively to infection, whereas timber products must be treated chemically to make them resistant to rotting.

"Not having immune systems, trees have evolved ways to beat infections by means of chemical and mechanical barriers"

Living trees can become infected by bacteria, fungi or viruses due to physical injury or damage, but, not having immune systems to neutralise infections, they have evolved ways of combatting pathogens by means of chemical and mechanical barriers. This is done in three distinct stages.

The first is strengthening of the walls between cells to isolate the living tissues from the source of harm and minimise the spread of damage.

The second is the setting up of four kinds of defence around the damaged area, in a process called compartmentalisation, which provides barriers to the spread of infection. The first of these is the formation of a gum that plugs the vascular channels in the sapwood, or xylem, to limit the spread of fungal filaments upwards and downwards to the rest of the tree. The second is the production in the xylem of chemical compounds that resist the spread of decay into the centre of the branch or trunk. The third prevents the spread of decay circumferentially round the active growth ring, or cambium, and is promoted by chemicals in a type of xylem cell with radial walls. The fourth is the generation by the cambium of a callus, just under the bark. This is called the barrier zone, and it consists of chemicals that spread outwards to prevent fungus from infecting new xylem. Woody tissue called woundwood then grows over time to close the damaged area.

The third stage of infection control is the growth of new tissues around the infected compartment, which is now full of compounds that kill the infective organisms and deprive them of their food supply. As long as the growth of new tissue in the tree outpaces the infection, the tree will survive. ▮

Answers

Quick quiz #287 *Answers*

1 Malala Yousafzai
2 Jupiter
3 Mohs Hardness Scale
4 Oxygen
5 1998

Quick crossword #175 *Answers*

ACROSS 7 Hoyle, **8** Gyroscope, **10** Goitre, **11** Rhinitis, **12** *Aeon Flux*, **13** Iota, **15** Fermium, **17** Pylorus, **20** Stat, **22** Sunspots, **25** Theremin, **26** Vostok, **27** T-junction, **28** Steel

DOWN 1 Bolometer, **2** Platinum, **3** Hydroxy, **4** Motility, **5** Schist, **6** Optic, **9** Cell, **14** Kurt Gödel, **16** Ultimate, **18** Opposite, **19** Xs and Os, **21** Turing, **23** Nova, **24** Thuja

#57 Prime jumps *Solution*

You must add 100 to 21 four times, giving 421, to reach a prime number. A starting number will never reach a prime if it is a multiple of 2 or 5, since it will have a common factor with 100. That leaves 40 numbers – those ending in 1, 3, 7 or 9.

Of these, 23 are prime. 27, 51, 69, 77, 81, 93, 97 all give non-primes when adding 400, and of the remainder only one has the required property: 87 = 3 × 29, 187 = 11 × 17, 287 = 7 × 41 and 387 = 3 × 129, but 487 is prime.

If we relax the requirement to start with a non-prime, then 19, 43 and 61 are added to our list, needing to get to 419, 443 and 461 to find another prime.

Nuke the climate

We all know that climate change is dangerous, which means it can be tempting to take drastic measures to tackle it. Such as building a nuclear bomb orders of magnitude bigger than any to date and setting it off deep under the seabed.

News reporter Alex Wilkins drew Feedback's attention to this little scheme. It is the brainchild of Andrew Haverly, who described his idea in a paper released on 11 January on arXiv, an online repository without peer review.

Haverly's plan builds on an existing approach called enhanced rock weathering. Rocks like basalt react with carbon dioxide in the air, slowly removing the greenhouse gas and trapping it in mineral form. By crushing such rocks to powder, we can accelerate this chemical weathering and speed up CO_2 removal. However, even under optimistic estimates, this will only mop up a small fraction of our greenhouse gas emissions.

That is where the nuke comes in. A decent nuclear explosion could reduce a large volume of basalt to powder, enabling a huge spurt of enhanced rock weathering. Haverly proposes burying a nuclear bomb at least 3 kilometres below the Southern Ocean seabed. The surrounding rocks would constrain the blast and radiation, minimising the risk to life. But the explosion would pulverise enough rock to soak up 30 years' worth of CO_2 emissions.

The first hurdle Haverly identifies is the scale of the bomb required. The largest nuclear explosion was that of Tsar Bomba, detonated by the USSR in 1961: it had a yield equivalent to 50 megatons of TNT. Haverly wants a bigger blast, a device with a yield of 81 gigatons, over 1600 times that of Tsar Bomba. Such a bomb, he writes solemnly, "is not to be taken lightly".

Quite how we are supposed to build this thing, then transport it to the notoriously windy Southern Ocean, safely lower it to the seabed, and then send it several km below said seabed, is very much left as an exercise for the reader. Haverly estimates this endeavour would cost "around $10 billion dollars", which would indeed be a lot of bang for your buck considering the huge costs of climate change. However, Feedback has no idea how he came up with that figure.

Anyway, nobody tell Elon Musk.

Twisteddoodles *for New Scientist*

TREES CAN USE AROMA TO TALK
URGH, WHAT'S THAT SMELL?
IT'S CALLED "GO AWAY!"
AS WELL AS FUNGAL NETWORKS IN THE SOIL
TELL HIM I'M SORRY AND I MISS HIM.
@twisteddoodles

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or New Scientist, 9 Derry Street, London, W8 5HY
Consideration of items sent in the post will be delayed

Afterlife sneak peak

Every so often, Feedback experiences a revelation through the medium of social media. Our most recent one came courtesy of an X user called @pallnandi, an occupational therapist and "unbiased realist", who on 12 January posted: "Leaked photo of heaven is going viral on social media. No wonder Christians are so determined to get there!😍"

The accompanying image shows a city carved out of white stone, with architecture that looks like a cross between the Hagia Sophia mosque in Istanbul, the Colosseum in Rome and Rivendell from *Lord of the Rings*. The hundreds of windows all glow the same shade of golden yellow. Above the city is a dark, starry sky, with what looks like the Milky Way streaking across it.

Hence Feedback's revelation: that if you wait long enough, a long-debunked silly claim will circulate yet again.

This one goes back to at least 1994, when the outlandish *Weekly World News* published a story headlined "Heaven photographed by Hubble telescope". It included a blurry black-and-white image of a starfield, with a huge glow in the middle that contained a collection of posh-looking buildings. Anyone who remembers what Asgard, home of the Norse gods, looked like in the *Thor* movies will have about the right idea.

It shouldn't need saying that this image wasn't from Hubble, or even NASA, and is fake. But it went viral as recently as February 2024, after being highlighted in videos on Instagram and TikTok.

It isn't even a year later, and a new image with a similar tagline has gone viral. Several reports have pointed out that the image looks AI-generated: the Milky Way, in particular, has glitch-like patterns in it.

Feedback's real issue with it, though, is that it looks like a dreadful place. For starters, the stars are crystal-clear, which implies a distinct lack of air. It looks freezing cold and the structures are like something designed by Adam Driver's monomaniacal architect character in the movie *Megalopolis*. Sci-fi author Naomi Alderman waded in on Bluesky: "Right so no animals – or plants or trees – or rivers or lakes – just cold marble – dark sky and no sun – literally can't see any people." She likens it to the output of "a terrifying neighbourhood committee which enforces absolute rigid uniformity".

Maybe one day we will get an iteration of this meme where heaven actually looks like a nice place to spend eternity. But Feedback doesn't recommend holding your breath for it.

A fishy finale

A press release alerts us to the new book *Into the Great Wide Ocean: Life in the least known habitat on Earth*, by Sönke Johnsen. In it, the author explains what we know about life in the vast volume of water below the ocean surface, isolated from the air, the seabed and continental shelves. What is it like, Feedback wonders, to spend all your life in a place where only the force of gravity and a slight variation in light levels can tell you which way is up and which is down?

We don't know, but we do know that the illustrator of this fishy tome is one Marlin Peterson.

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